

ANNALS of SURGERY

A Monthly Review of Surgical Science and Practice

Edited by
LEWIS STEPHEN PILCHER, M.D., LL.D.
of New York

With the Collaboration of
SIR WILLIAM MACLEWEN, M.D., LL.D. SIR W. WATSON CHEYNE, C.B., F.R.S.
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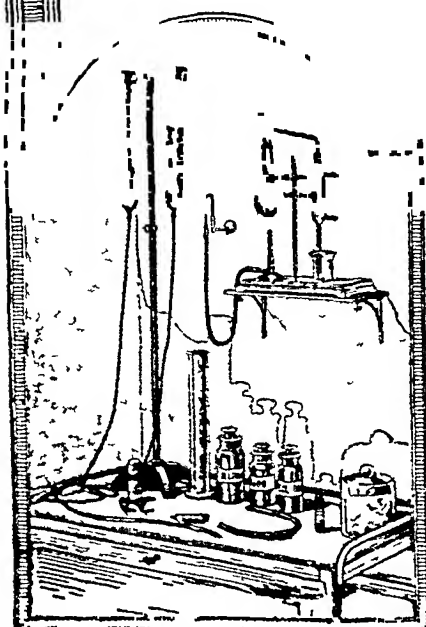
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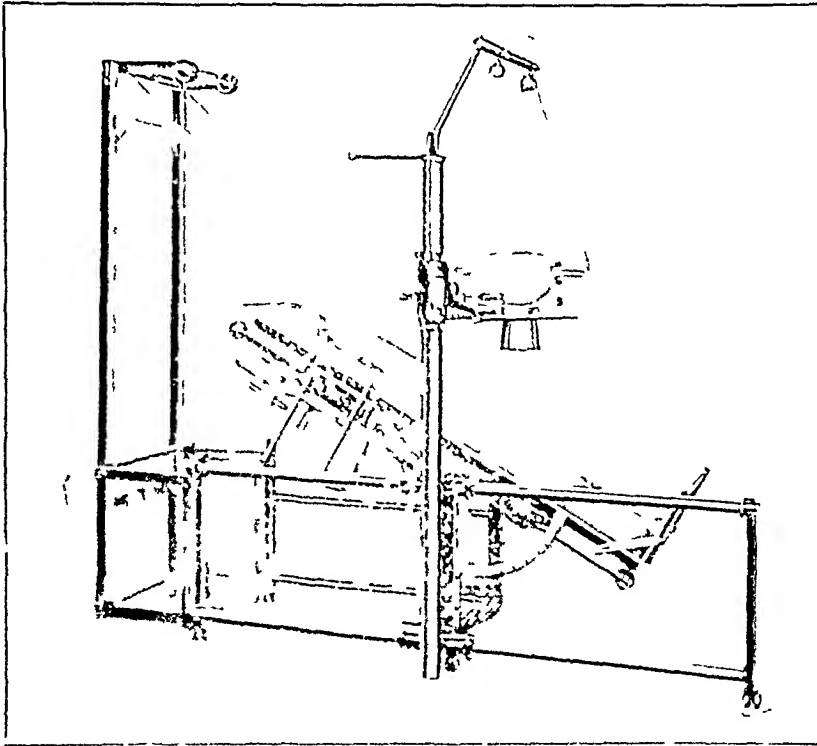


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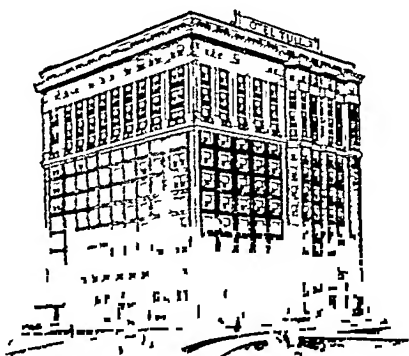
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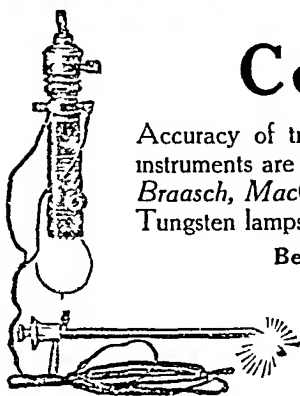
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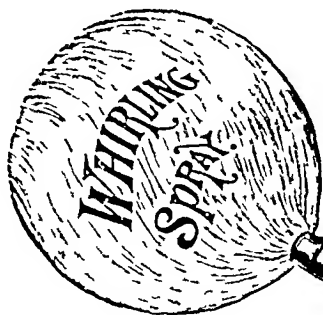
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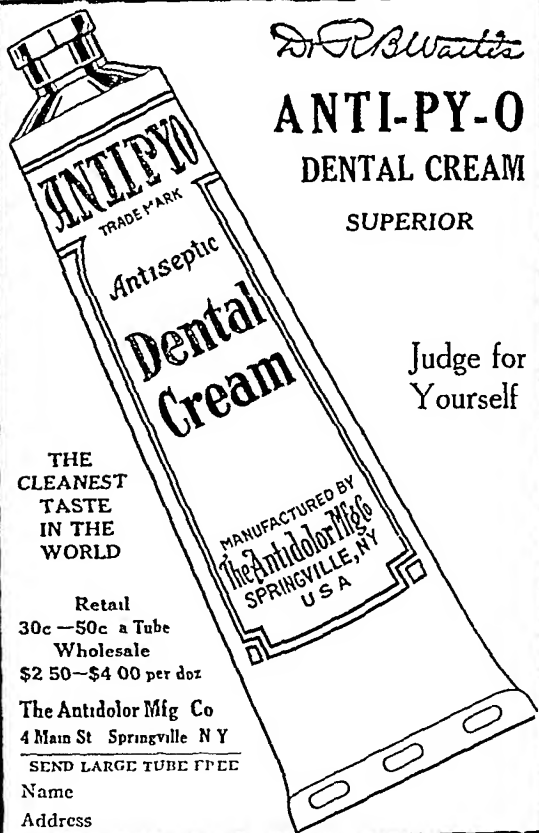
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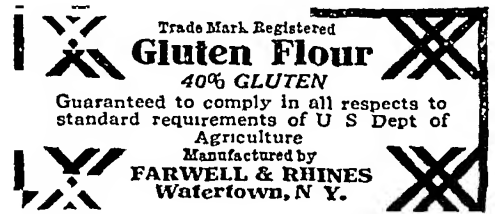
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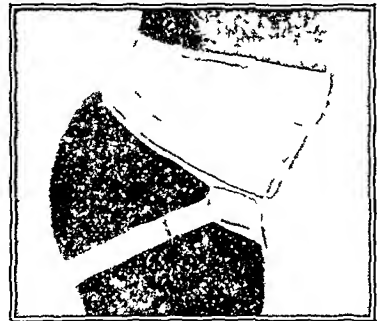
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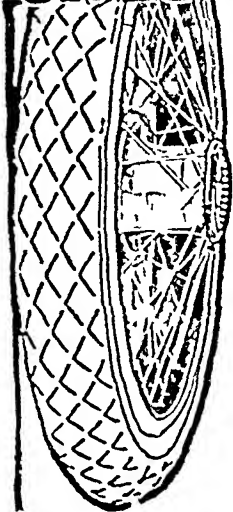


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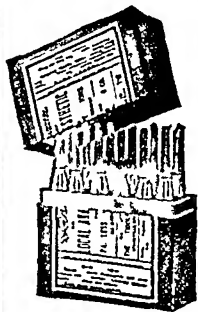
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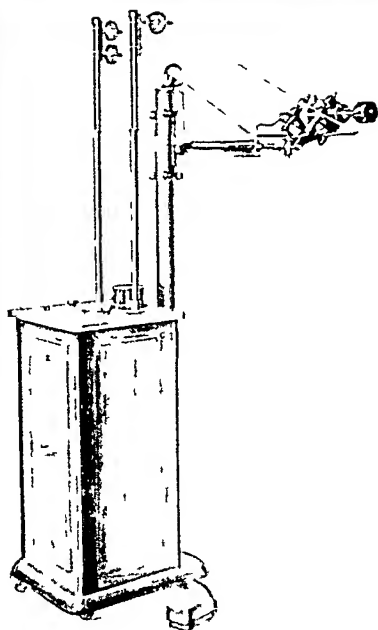
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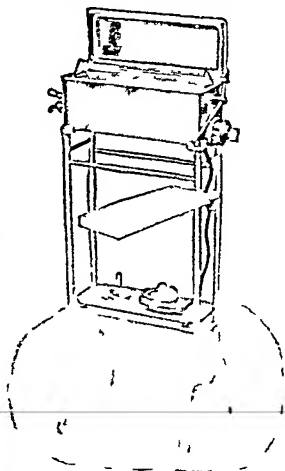
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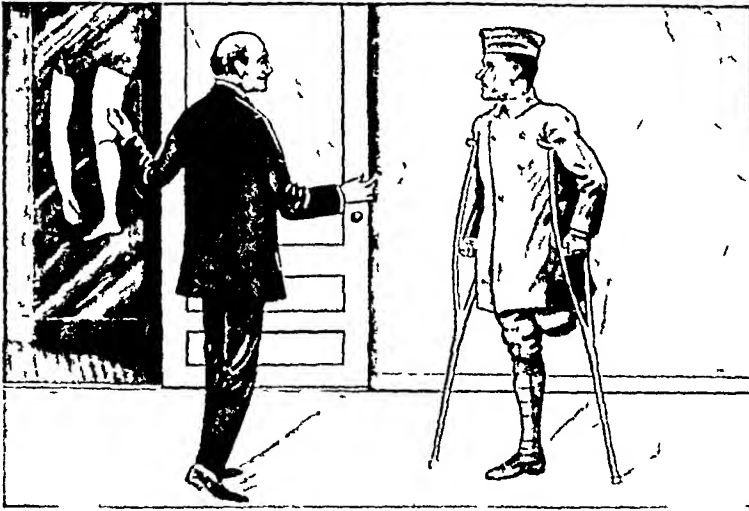
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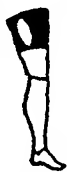
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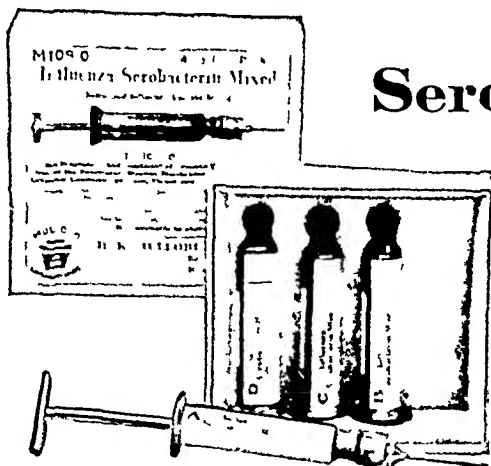
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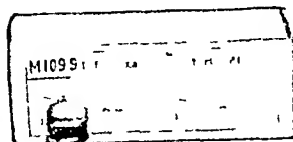
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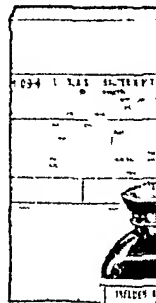
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Boilable

CLAUSTRO-THERMAL, meaning *enclosed heat*, is descriptive of the improved method of heat sterilization. The principle of the method consists in applying the heat after closure of the tubes, thus avoiding all the chances of accidental contamination.

The sealed tubes are submerged in a bath of cumol—the high boiling hydrocarbon. The temperature of the cumol bath is gradually elevated until at the end of six hours the maximum of 165° C (329° F) is reached. This temperature is maintained for five hours, and is then allowed to slowly decline. The temperature curve is graphically represented by the chart shown below.

It is obvious, therefore, that sterility is absolutely assured. The sutures, being stored in their original tubing fluid and reaching the surgeon's hands sealed within the tubes in which they were sterilized, are removed from all the chances of contamination incident to the customary method of sterilizing the strands in open tubes.

Sterilization by this integral method is made feasible through the use of toluol as the tubing fluid. The discovery of the value of toluol for this purpose was the outcome of an investigation aimed at finding a suitable fluid to replace chloroform. The latter was formerly in general use, but was unsatisfactory because it was found to break down into chemical products which not only exerted an extremely harmful action on the collagen of the

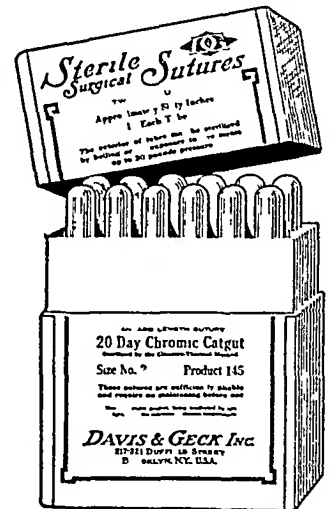
sutures but which were responsible for considerable wound irritation.

No other mode of sterilization so completely fulfills the exacting requirements for the production of ideal sutures as does the Claustro-Thermal method. Through its use the natural physical characteristics of the strands are preserved, while the destruction of all bacterial life is absolutely assured.

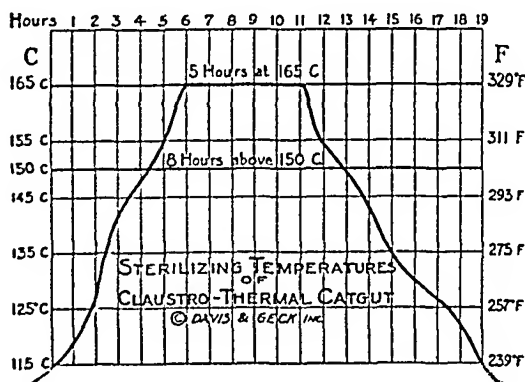
Claustro-Thermal sutures are not impregnated with any germicidal substance, and consequently they exert no bactericidal influence in the tissues.

This product embodies all the essentials of the perfect suture, such as compatibility with tissues, accuracy of size, maximum tensile strength, perfect and dependable absorbability, and absolute sterility.

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40-Day Chromic Catgut	Product No 185

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An Improved Germicidal Suture Superseding Iodized Catgut

KALMERID CATGUT is not only sterile, but, being impregnated with potassium-mercuric-iodide—a double iodine compound—the sutures exert a local bactericidal action in the tissues

The older practise of impregnating catgut with the ordinary crystalline iodine for this purpose was at best an unsatisfactory method, since the anti-septic power was but slight and transient. The most serious deficiencies of such iodized sutures, however, were their instability and weakness arising from exposure to light, the deterioration resulting from the continuous and unpreventable oxidizing action of the iodine, and the disintegration of the sutures when heated. Moreover, the decomposition products of iodine caused such sutures to be irritating.

These serious disadvantages of iodized catgut have been overcome through the use of potassium-mercuric-iodide instead of iodine. This double salt of iodine and mercury, the chemical formula of which is $\text{HgI}_2 \cdot 2\text{KI}$, is one of the most active germicides known, exerting a killing action on bacteria about ten times greater than that of iodine. It does not break down under the influence of light or heat, it is chemically stable, and, in the proportions used, is neither toxic nor irritating to the tissues. It interferes in no way with the absorption of the sutures, and is not precipitated by the proteins of the body fluids.

Kalmerid catgut, in addition to its bactericidal attribute, embodies all the essentials of the perfect suture. It is perfectly compatible with the tissues, its absorbability is dependable, and its tensile strength is particularly good.

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20-Day Chromic	Product No 1245	20-Day Chromic	Product No 1445
40-Day Chromic	Product No 1285	40-Day Chromic	Product No 1485

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Two Varieties—Boilable and Non-Boilable

THESE are the sutures *par excellence* for those procedures in which post-operative tension is excessive, or long continued apposition necessary, such as in herniotomy, and in tendon and bone suturing. Kalmerid kangaroo tendons are not only sterile, but, in addition, they are impregnated with potassium-mercuric-iodide, which enables them to exert a local bactericidal action in the tissues. The impregnating and sterilizing methods are the same as practised in the preparation of Kalmerid catgut, and described on the preceding page.

They are genuine kangaroo tendons, they are round, smooth, straight, of uniform contour, and possess a tensile strength about twice that of the best catgut of equivalent size.

Because of their greater strength some surgeons prefer these tendons to catgut, particularly in the finer sizes, for general intestinal, muscle, fascia, and skin suturing.

ABSORPTION TIME—The tendons are chromicized, and so accurately is the chromicizing process regulated that each size, whether it be the finest or the coarsest, will maintain apposition in fascia

or in tendon for approximately thirty days. Shortly after that period the sutures, with their knots, will be completely absorbed.

TWO VARIETIES—Kalmerid kangaroo tendons are prepared in two grades—boilable and non-boilable.

The **NON-BOILABLE** tendons are extremely pliable and consequently require no moistening.

The **BOILABLE** tendons are quite stiff as they come from the tubes, but may be rendered pliable by moistening in sterile water preliminary to use. The smaller sizes will be sufficiently softened by fifteen minutes immersion, while the larger sizes should be immersed for about thirty minutes. Either sterile water, or an aqueous bactericidal solution made with Kalmerid tablets—1:5000—should be used.

Before immersion, the toluol, which is very volatile, should be allowed to evaporate so that the water may have access to the sutures.

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Each Tube Contains One Tendon Lengths Vary From 12 to 20 Inches

The Non-Boilable Grade is *Product No. 370*

Boilable Grade is *Product No. 380*

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Catgut Sizes	0	2	4	6	8

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00	_____
0	_____
1	_____
2	_____
3	_____
4	_____
6	_____
8	_____

Standardized Sizes

The Established Metric System of Catgut Sizes
is Now Used For All Sutures

IN conformity with the long recognized need for a unified system of sizes, the standard metric catgut scale has been extended to embrace all sutures, including kangaroo tendons, silk, horsehair, silkworm gut, and celluloid-linen thread.

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360	Horsehair	Four 28-Inch Sutures	00
390	Plain Silk worm Gut	Four 14-Inch Sutures	00, 0, 1
400	Black Silk worm Gut	Four 14-Inch Sutures	00, 0, 1
450	White Twisted Silk	60 Inches	000, 00, 0, 1, 2, 3
460	Black Twisted Silk	60 Inches	000, 0, 2
480	White Braided Silk	60 Inches	00, 0, 2, 4
490	Black Braided Silk	60 Inches	00, 1, 4
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Short Length Without Needles

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Product No	Material	Approximate Quantity in Each Tube	Catgut Sizes
802	Plain Catgut	20 Inches	00, 0, 1, 2, 3
812	10-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
822	20-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
862	Horsehair	Two 28-Inch Sutures	00
872	Plain Silk worm Gut	Two 14-Inch Sutures	0
882	White Twisted Silk	20 Inches	000, 0, 2
892	Umbilical Tape	Two 12-Inch Ligatures	

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With Needles

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Product No	Material	Approximate Quantity in Each Tube	Catgut Sizes
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914	10-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
924	20-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
964	Horsehair	Two 28-Inch Sutures	00
974	Plain Silk worm Gut	Two 14-Inch Sutures	0
984	White Twisted Silk	20 Inches	000, 0, 2

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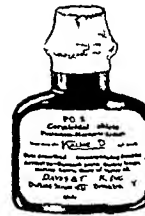
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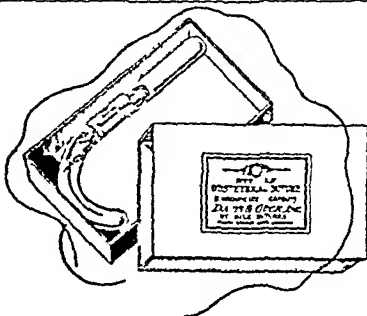
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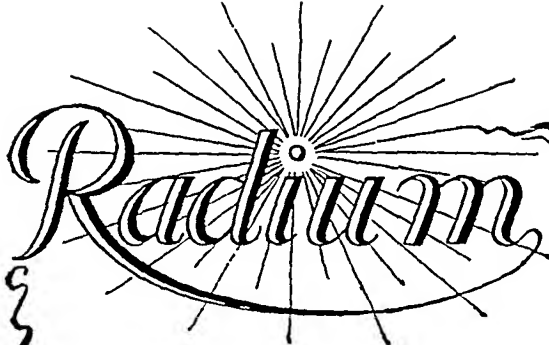
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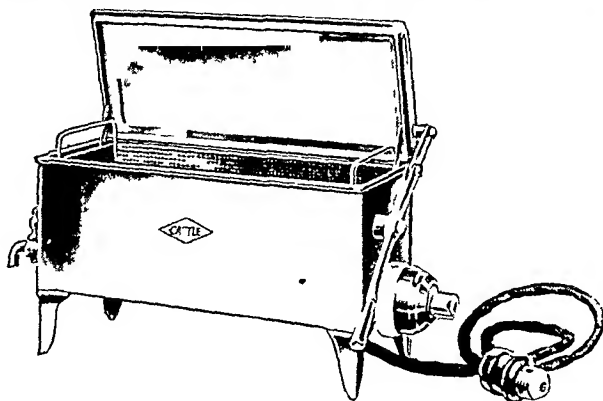
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Adrenalin in Medicine

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In the rôle of synergist to the anesthetic Adrenalin serves a threefold purpose, it blanches the tissues, giving the surgeon a clear field of operation, it confines the anesthetic to the area into which it is infiltrated, preventing absorption and possible toxic manifestations, it intensifies and prolongs the anesthesia by diminishing the circulation, thus obviating the dilution, oxidation and rapid destruction of the anesthetic in the tissues.

The question of the quantity of Adrenalin to be injected with the local anesthetic solution deserves special consideration on the part of the surgeon. It should be remembered that after the effects of the injection of a *large* dose of Adrenalin have been dissipated, after the local ischemia has subsided, the patient is liable to have a secondary hemorrhage, owing to a reaction in the walls of the

vessels which manifests itself in obstinate dilatation. Many instances of sloughing are attributable to the strangulation ensuing upon the injection of too much Adrenalin. It is incumbent upon the surgeon, therefore, to regulate carefully the Adrenalin content of the anesthetic solutions he employs.

In laparotomies and other major operations in which an ounce or more of anesthetic solution is required the proportion of Adrenalin need not exceed 1 in 100,000. This concentration can be approximated by adding five drops of the 1:1000 Adrenalin to the ounce of anesthetic solution. When smaller quantities are to be injected it is permissible to increase the Adrenalin proportion to 1:50,000 or 1:40,000.

The most satisfactory results are obtained by first sterilizing (boiling) the anesthetic solution and then, after it has partly cooled, to add the requisite number of drops of Adrenalin 1:1000. This permits of gratifying flexibility, the surgeon is enabled to vary the proportion of Adrenalin in the anesthetic fluid at will and with a minimum of inconvenience.



PARKE, DAVIS & COMPANY

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SODIUM
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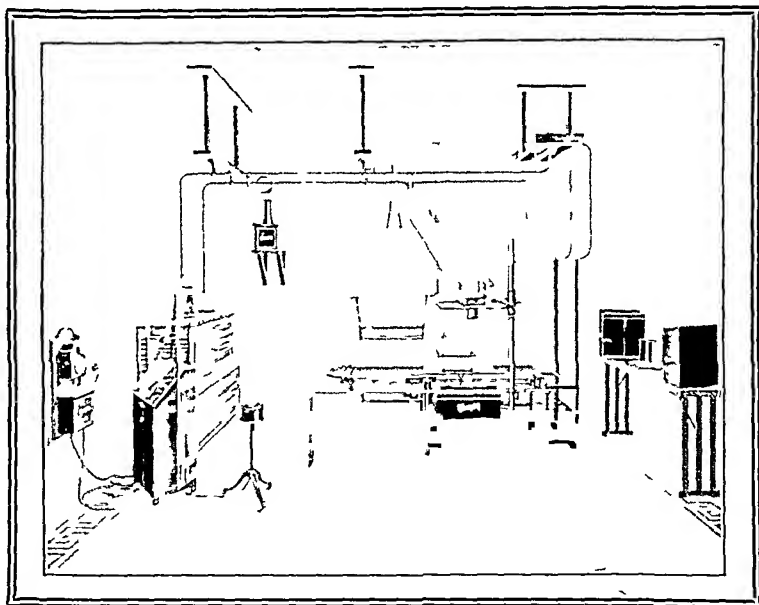
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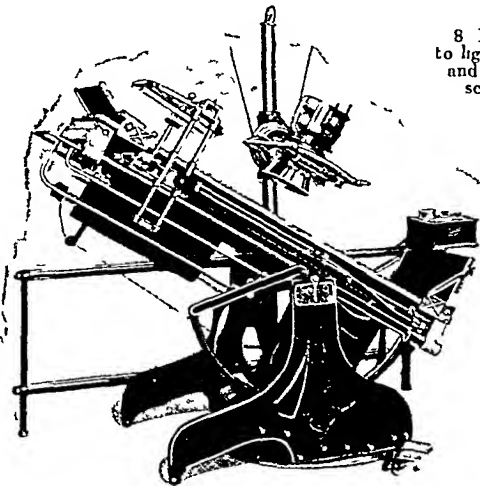
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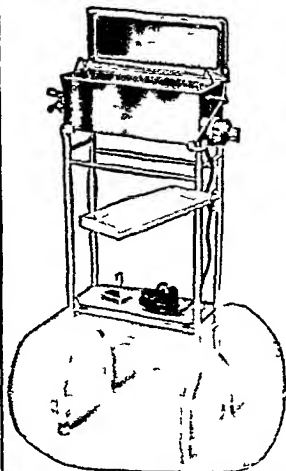
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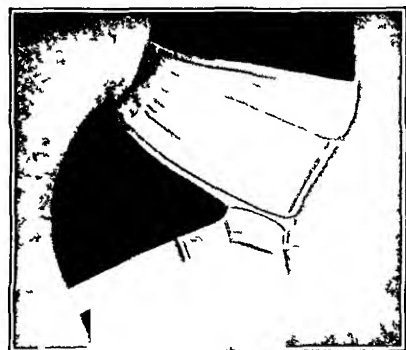
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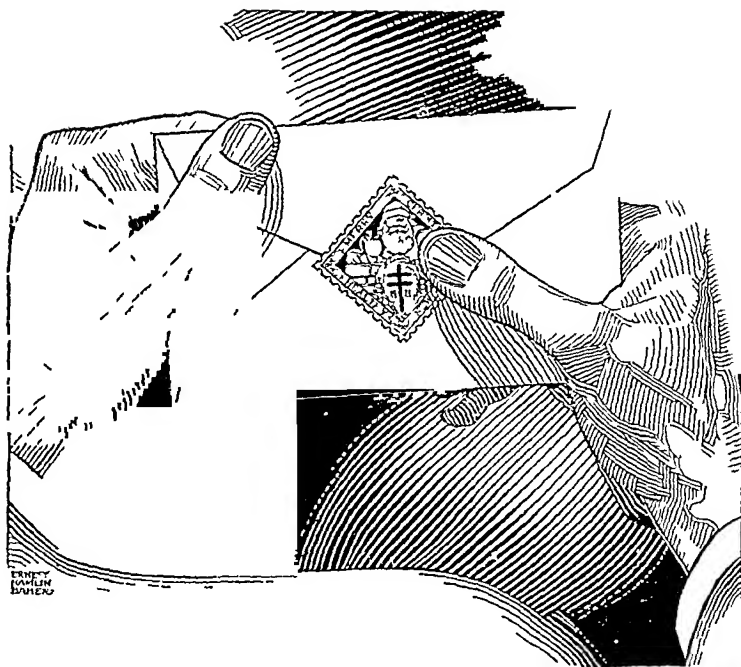
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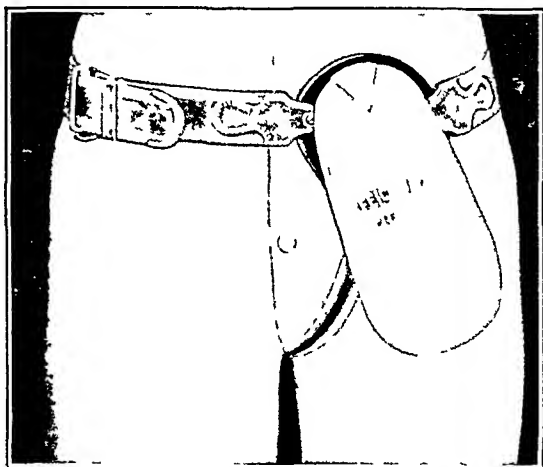


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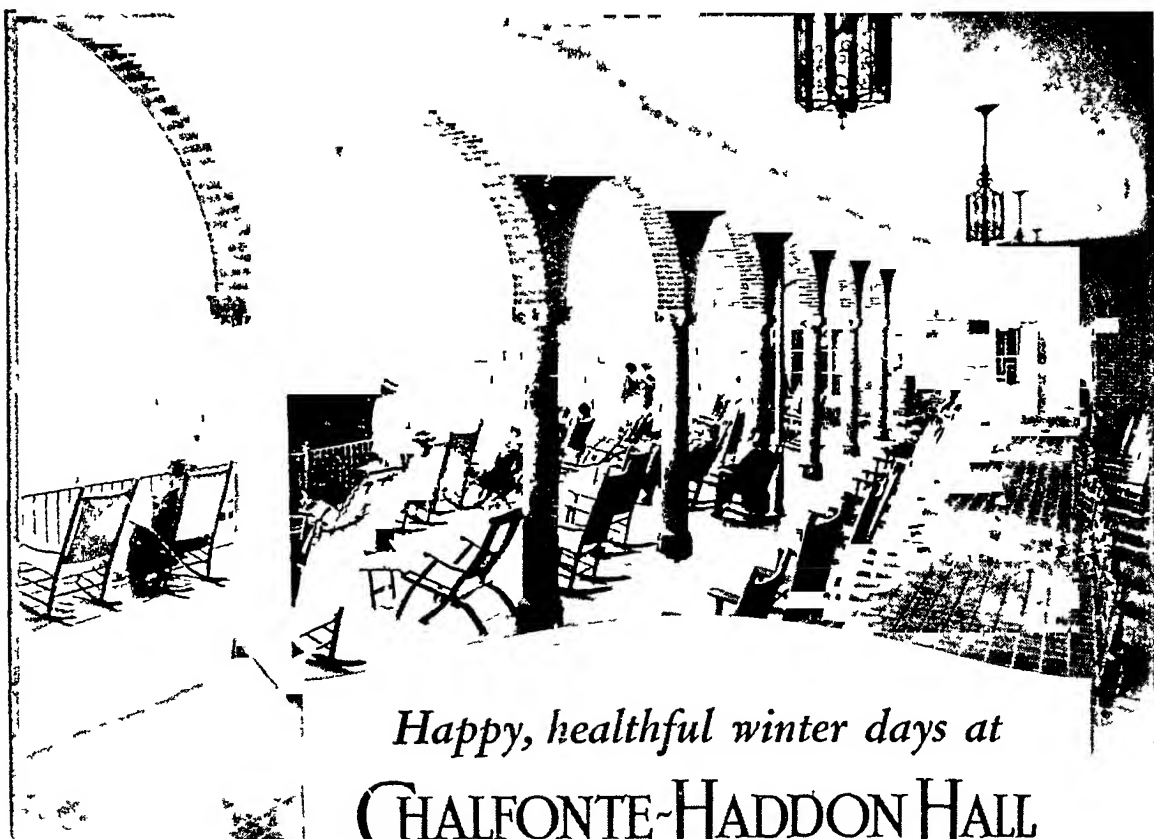
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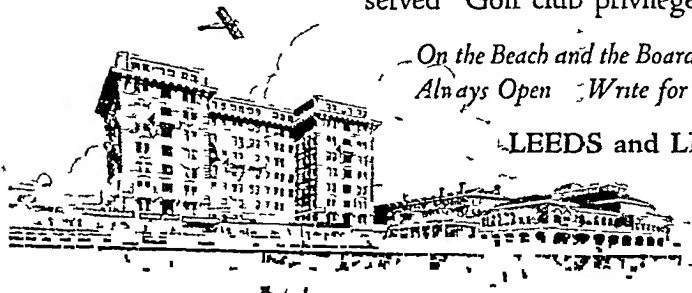


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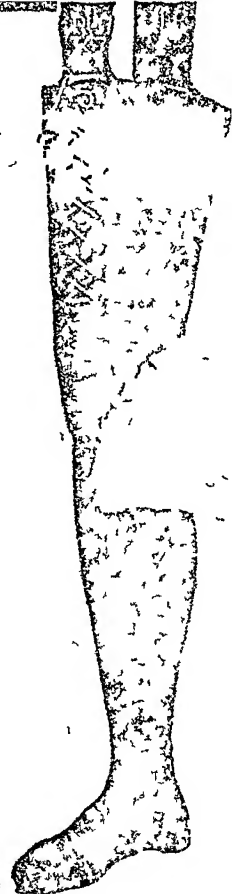
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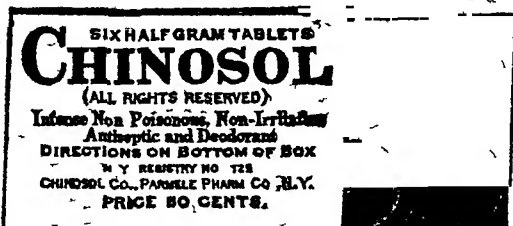
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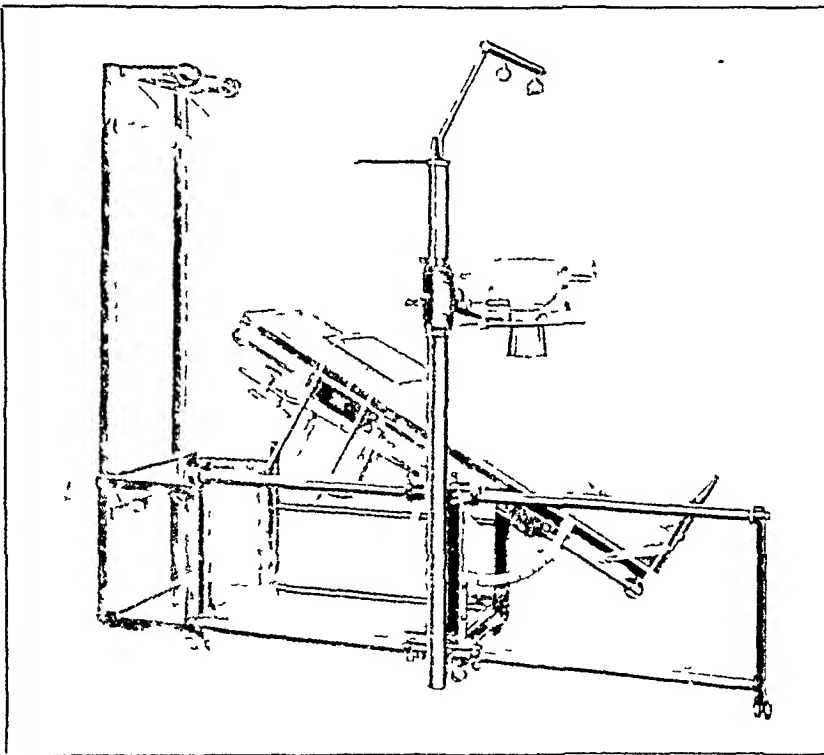
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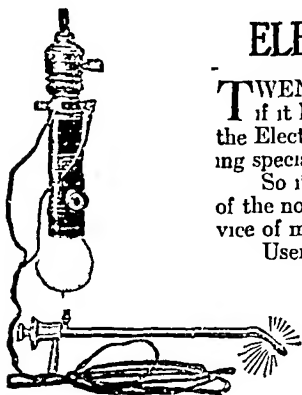
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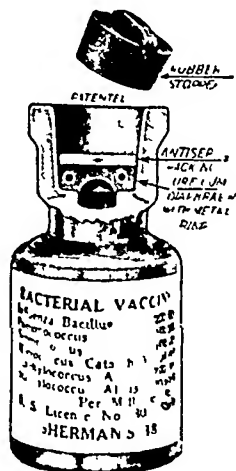
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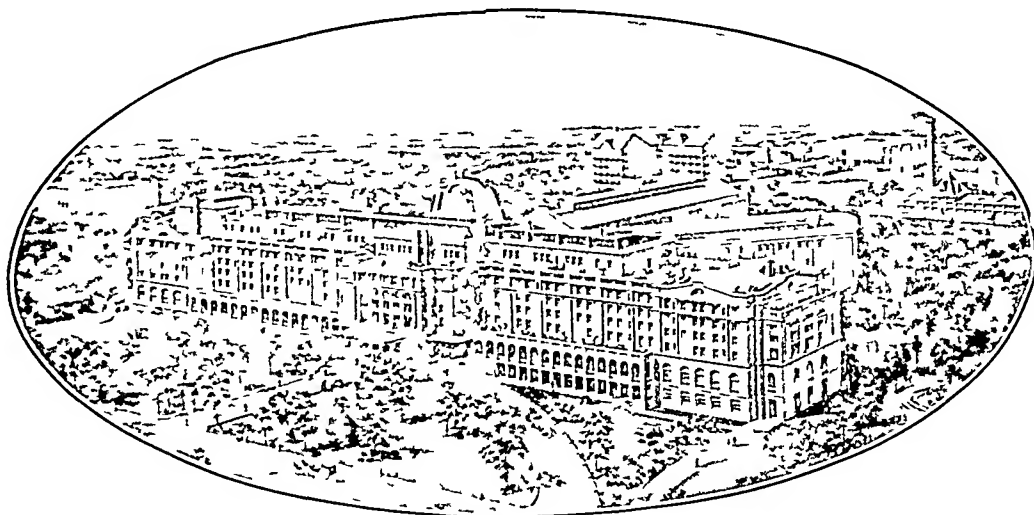
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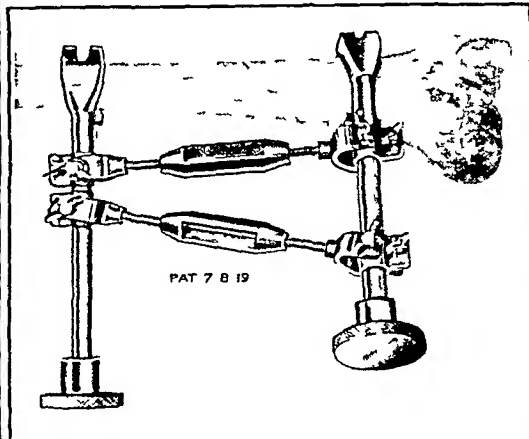
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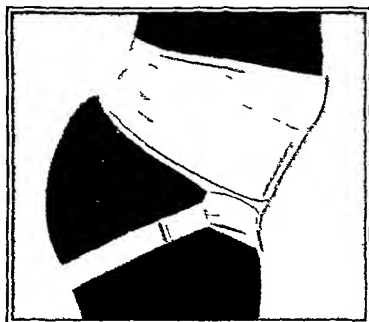
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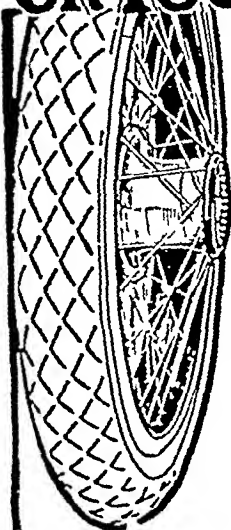
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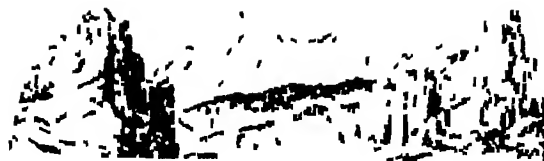
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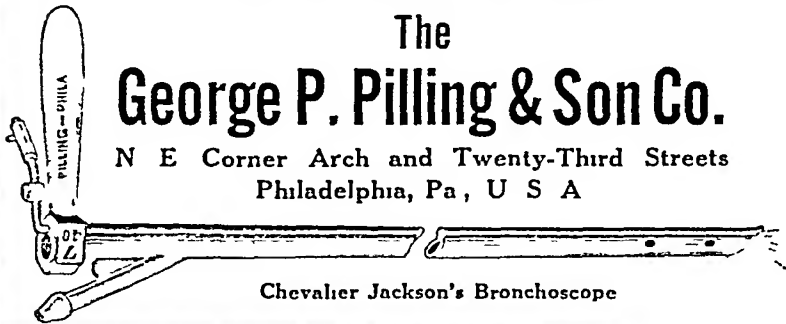
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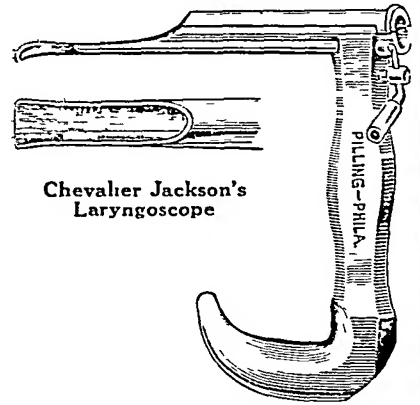
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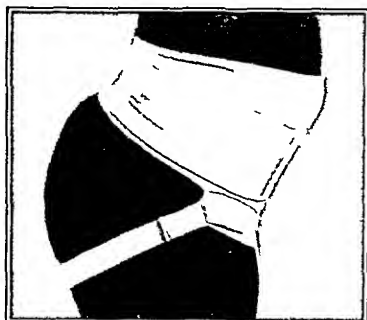
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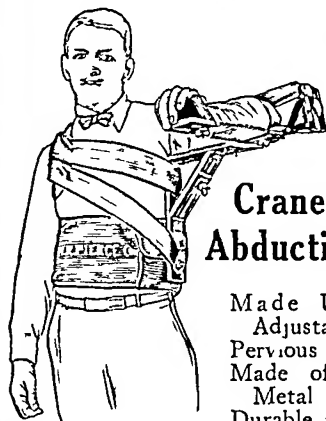
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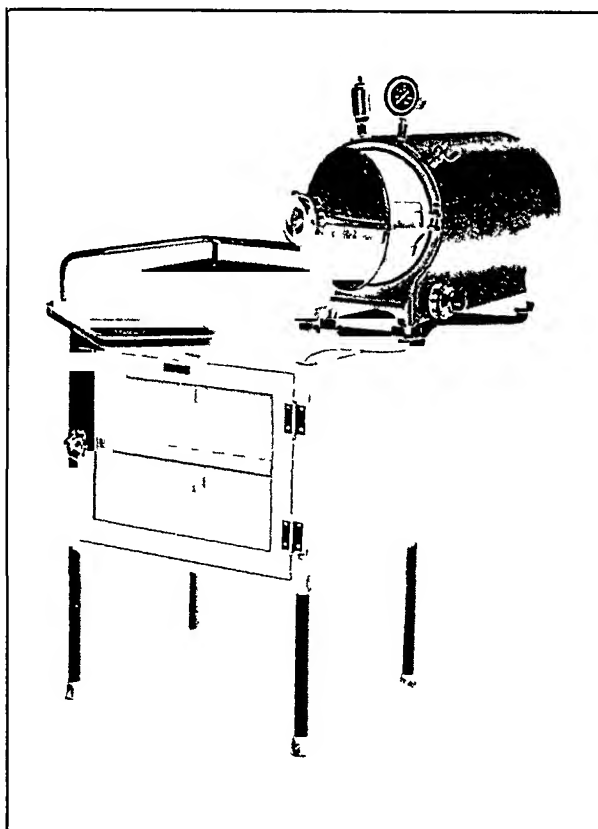
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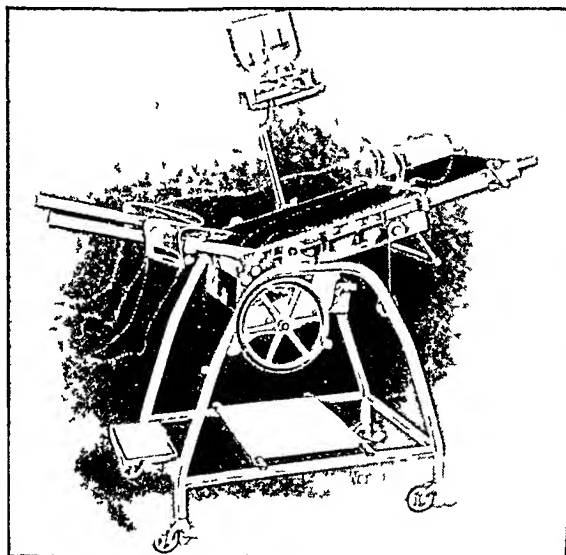
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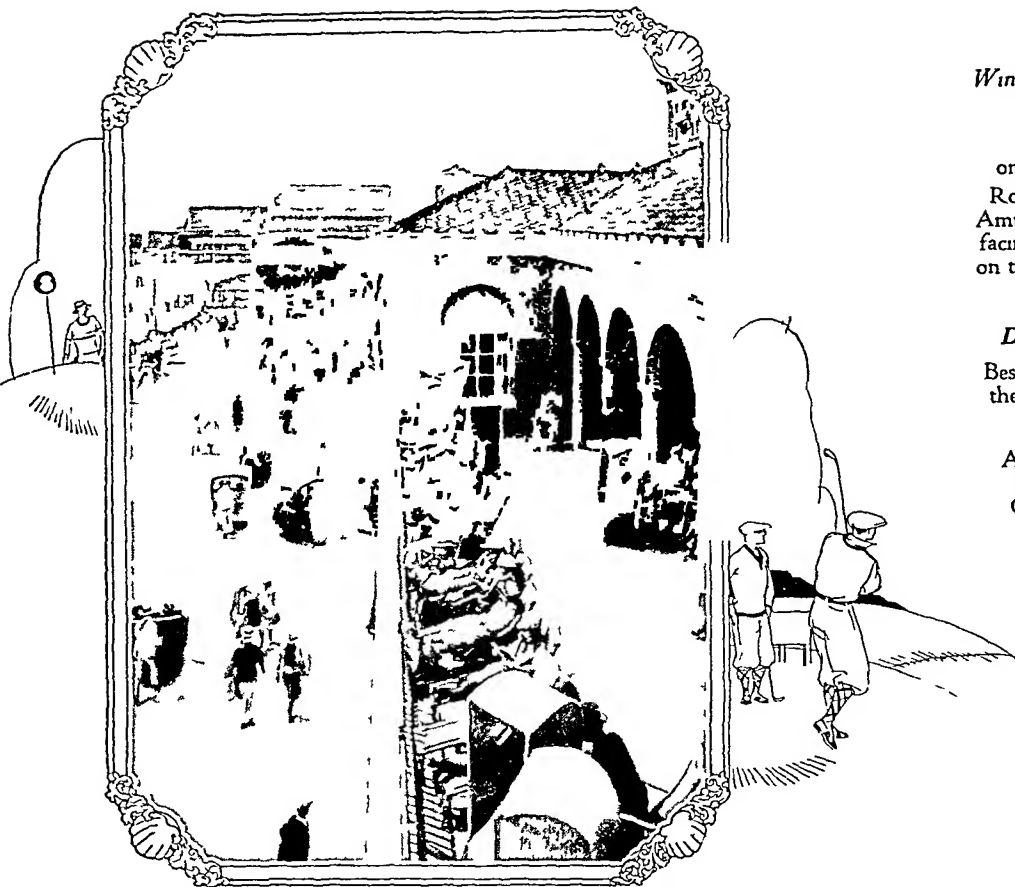
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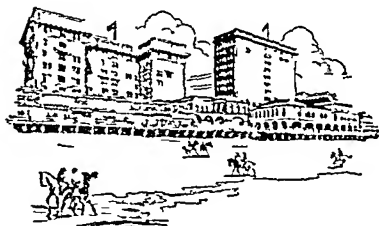


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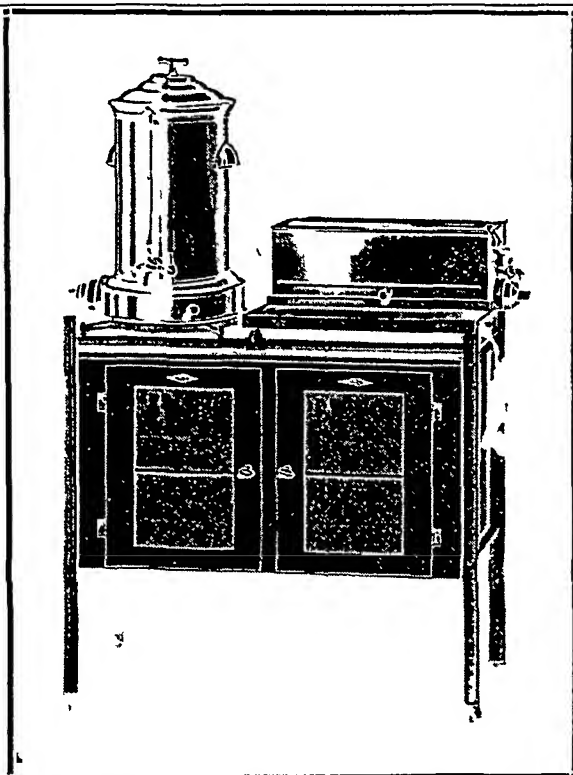
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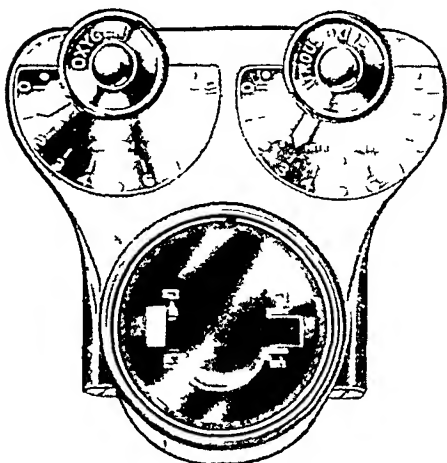
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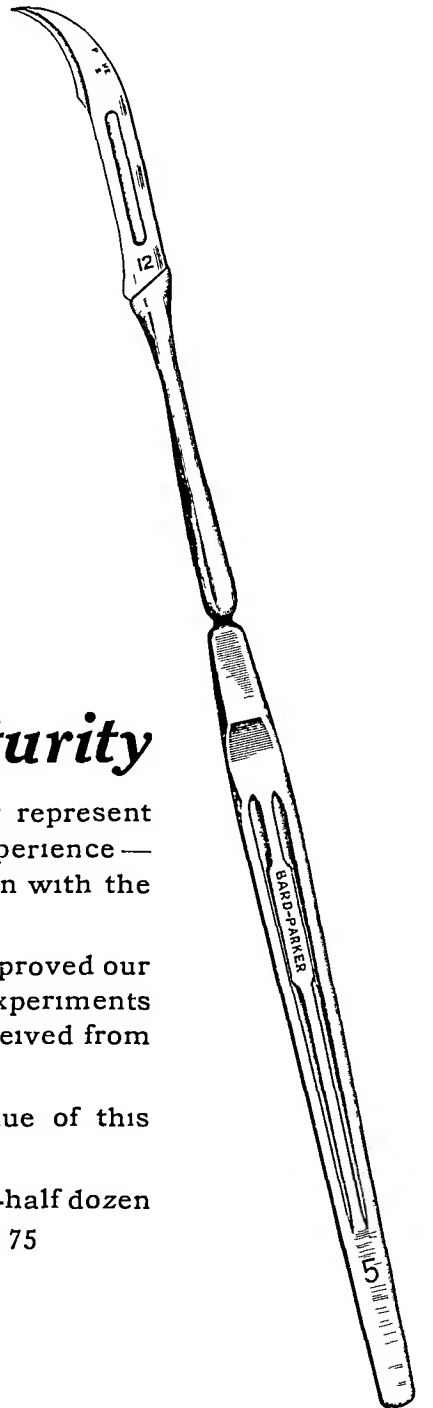
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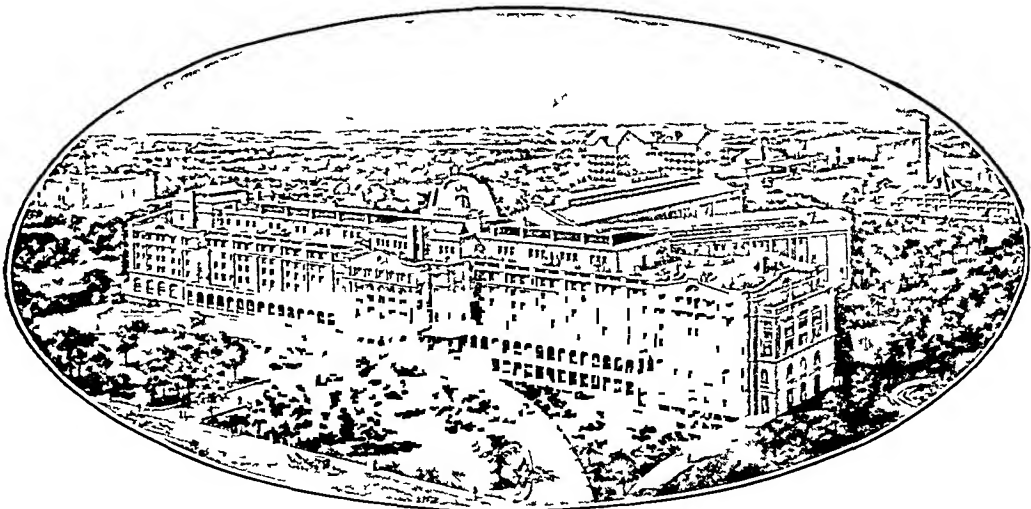
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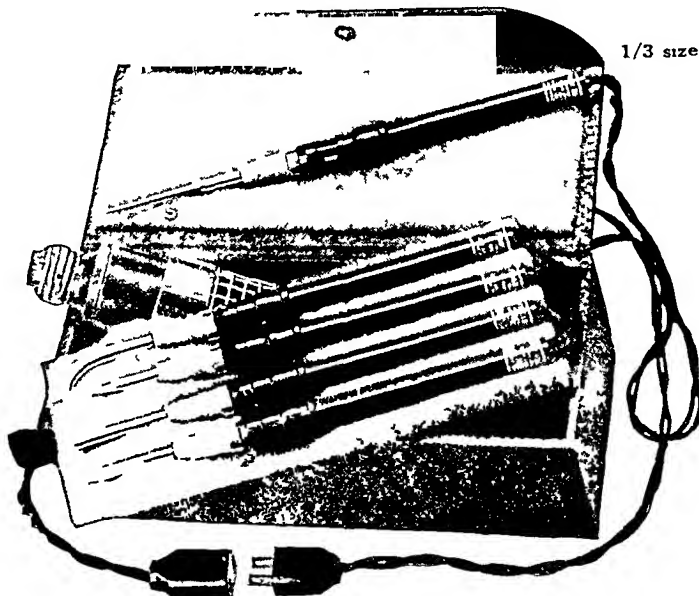
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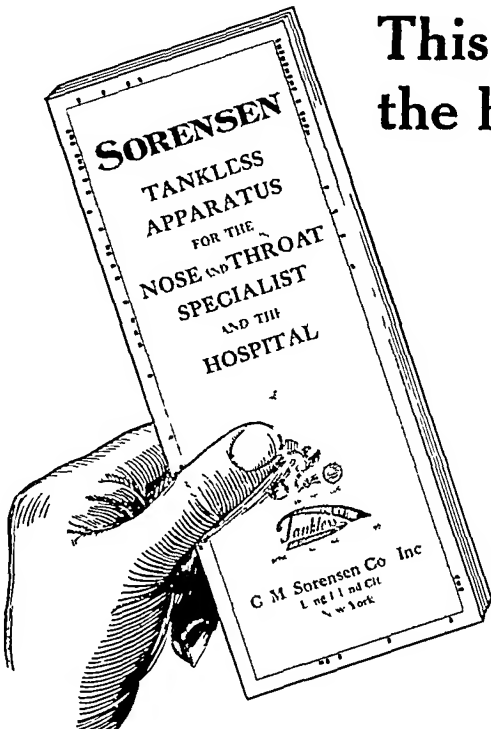
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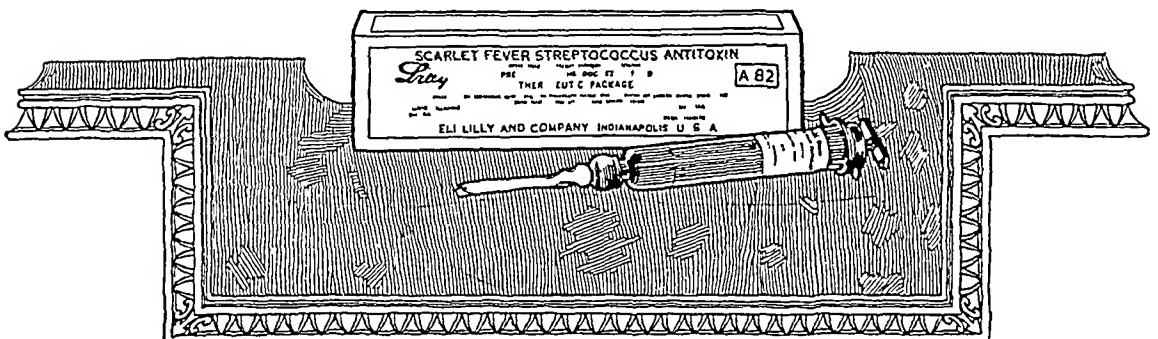
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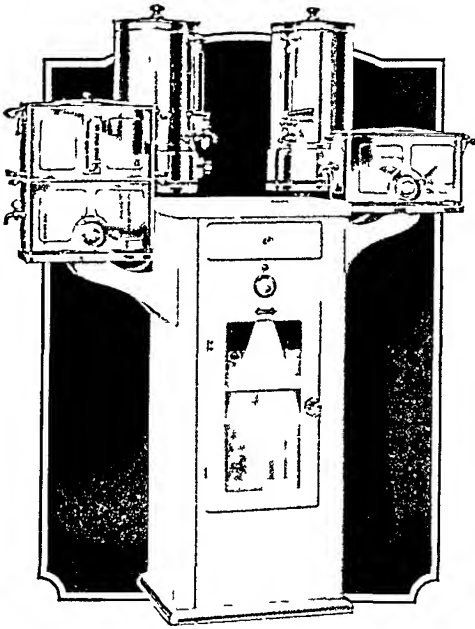
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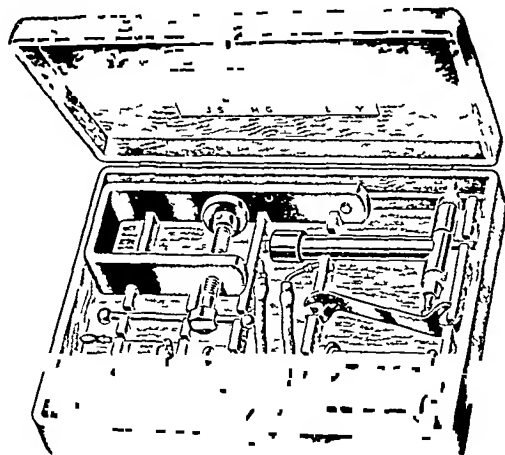
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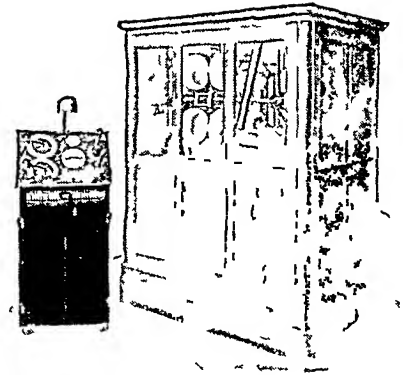
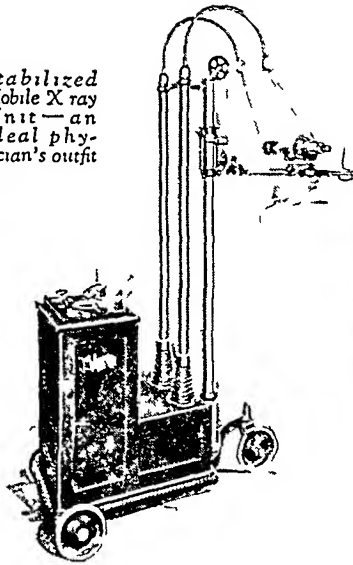
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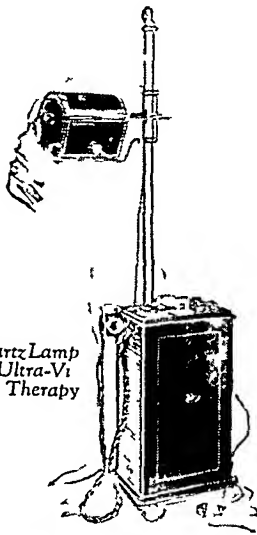
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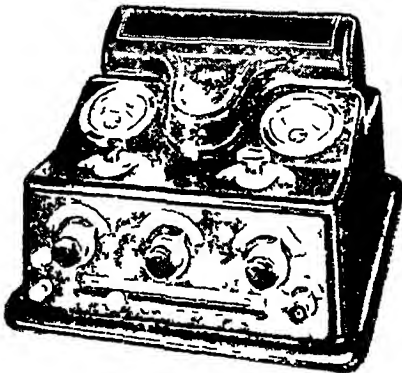
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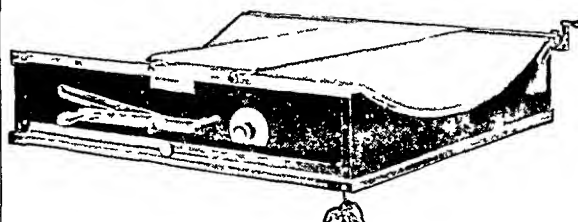
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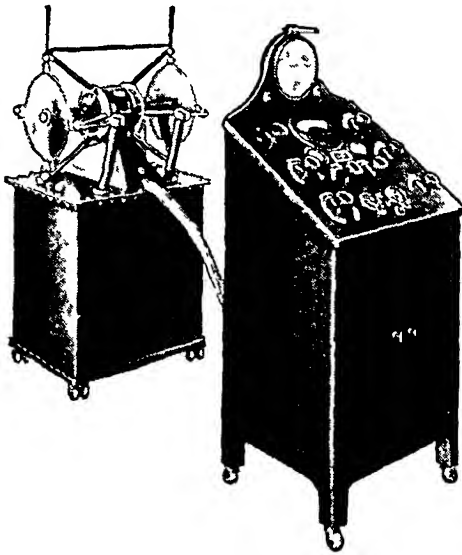
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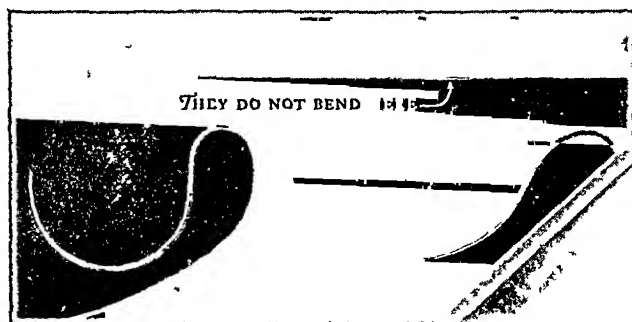
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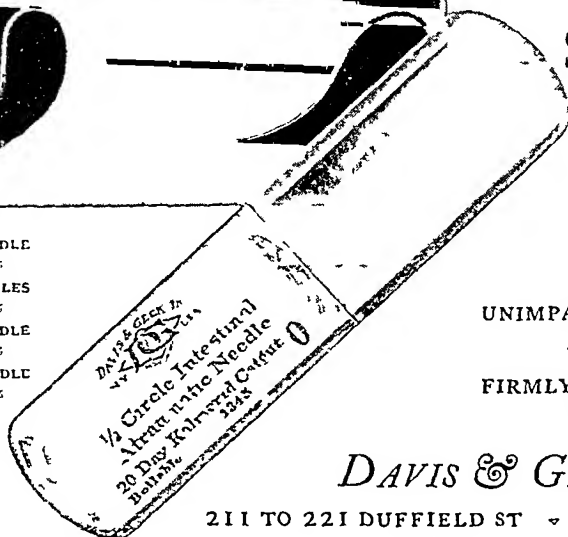
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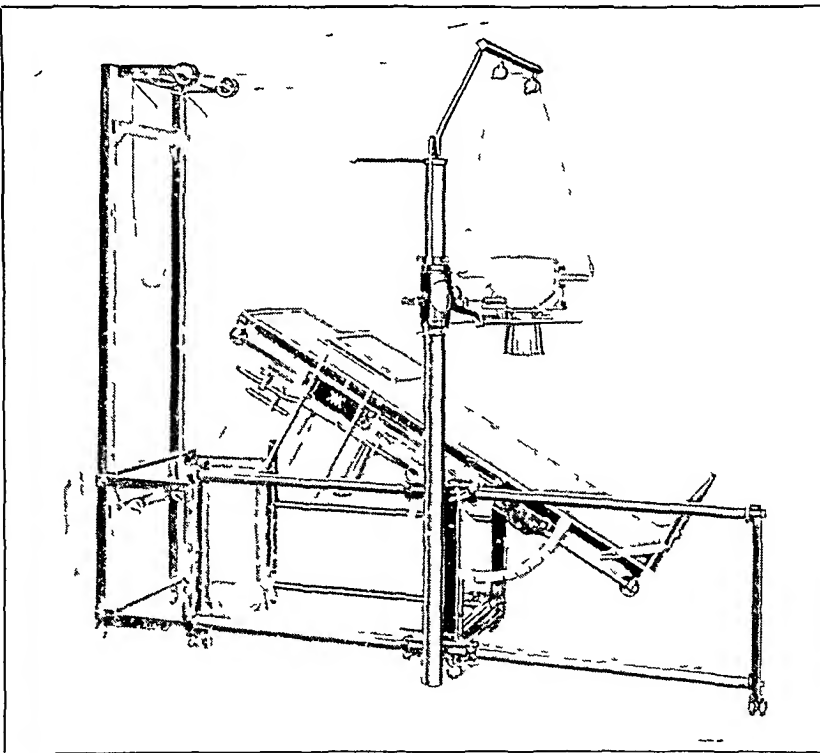
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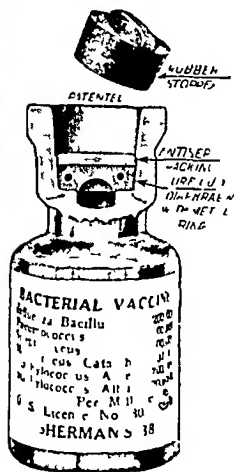
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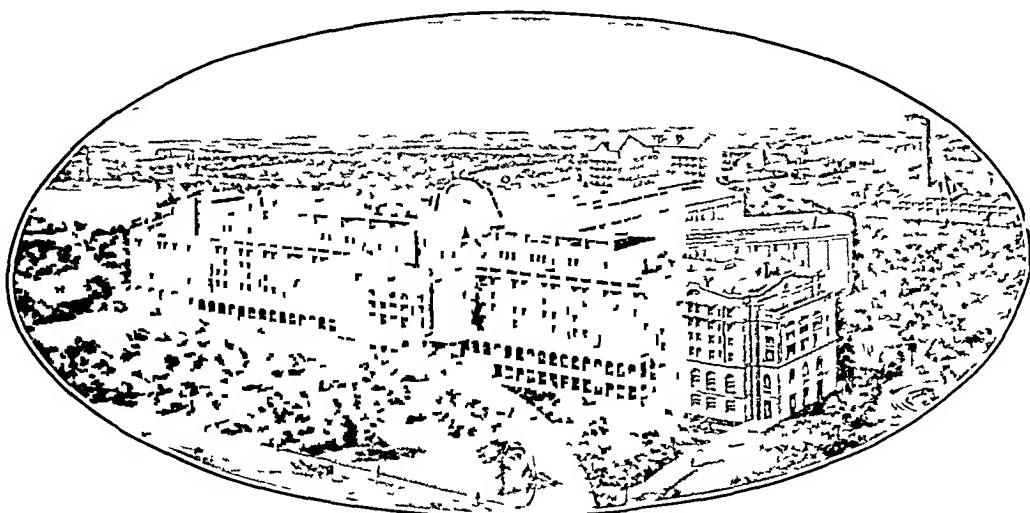
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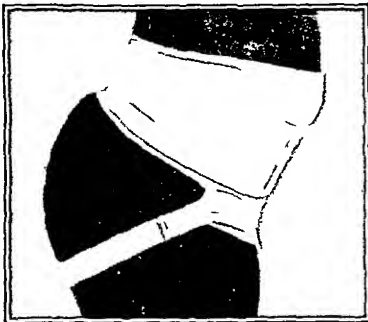
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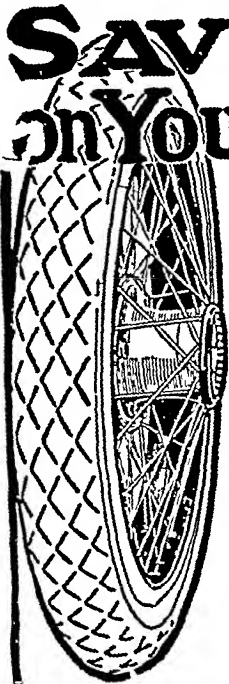
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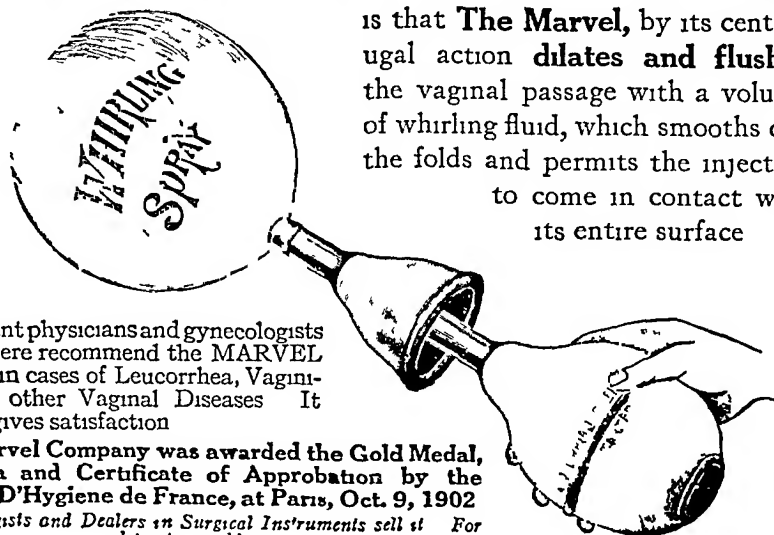


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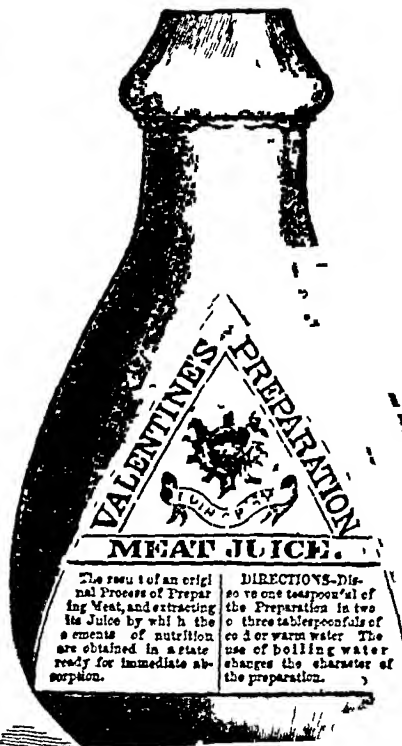
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A Monthly Review of Surgical Science and Practice

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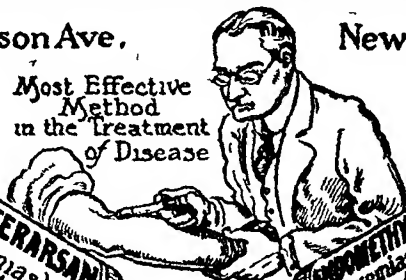
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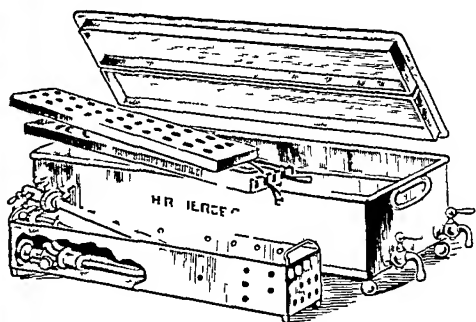
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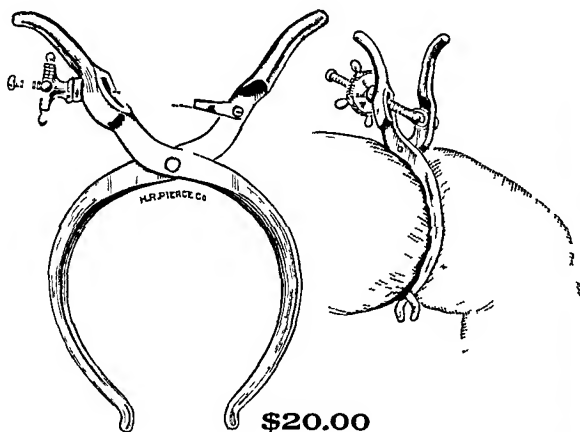
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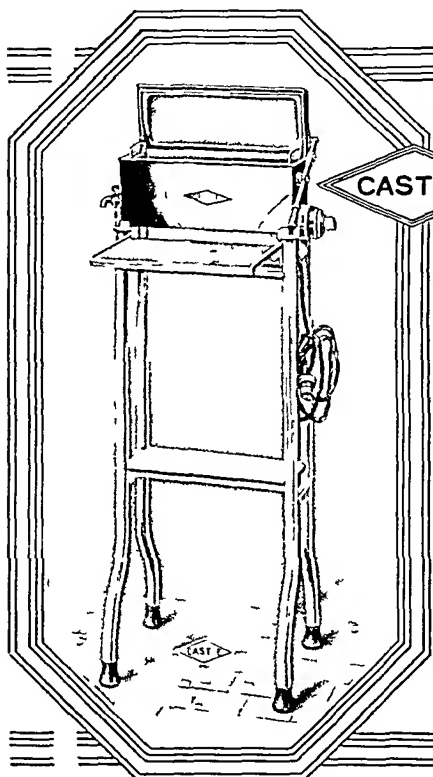
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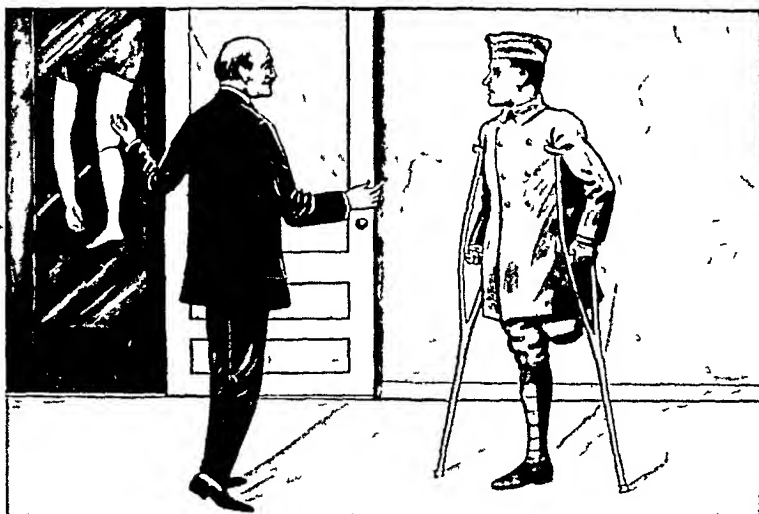
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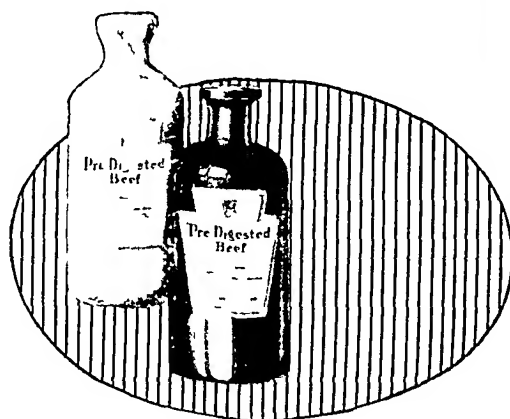
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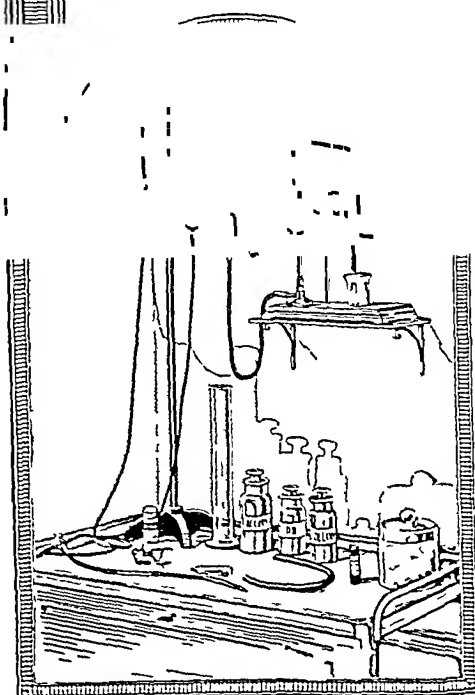
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When the chapters on the practice of gynecology are reached, all the procedures that have found a stable setting in practice are considered, and usually more than one method is offered

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The work is most comprehensive, and deals in a highly instructive way not only with diseases of women, but also with those coincident renal and abdominal lesions that are frequently encountered in the course of gynecologic affections

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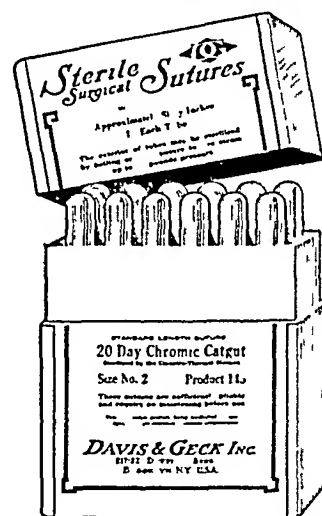
sutures but which were responsible for considerable wound irritation.

No other mode of sterilization so completely fulfills the exacting requirements for the production of ideal sutures as does the Claustro-Thermal method. Through its use the natural physical characteristics of the strands are preserved, while the destruction of all bacterial life is absolutely assured.

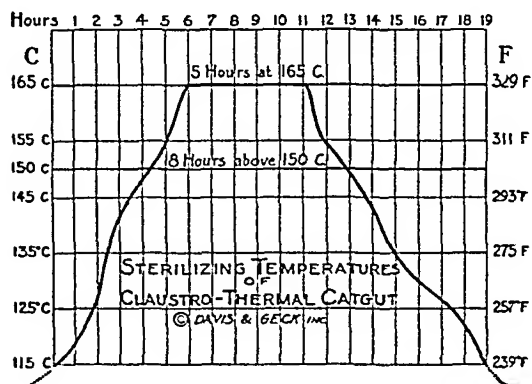
Claustro-Thermal sutures are not impregnated with any germicidal substance, and consequently they exert no bactericidal influence in the tissues.

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The older practise of impregnating catgut with the ordinary crystalline iodine for this purpose was at best an unsatisfactory method, since the anti-septic power was but slight and transient. The most serious deficiencies of such iodized sutures, however, were their instability and weakness arising from exposure to light, the deterioration resulting from the continuous and unpreventable oxidizing action of the iodine, and the disintegration of the sutures when heated. Moreover, the decomposition products of iodine caused such sutures to be irritating.

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They are genuine kangaroo tendons, they are round, smooth, straight, of uniform contour, and possess a tensile strength about twice that of the best catgut of equivalent size.

Because of their greater strength some surgeons prefer these tendons to catgut, particularly in the finer sizes, for general intestinal, muscle, fascia, and skin suturing.

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Before immersion, the toluol, which is very volatile, should be allowed to evaporate so that the water may have access to the sutures.

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~ Sizes ~

Tendon Sizes	Ex Fine	Fine	Medium	Coarse	Ex Coarse
Standardized Sizes	0	2	4	6	8

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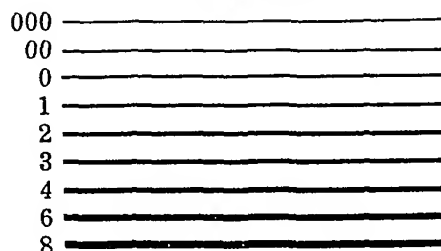
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360	Horsehair	Four 28-Inch Sutures	00
390	Plain Silk Worm Gut	Four 14-Inch Sutures	00, 0, 1
400	Black Silk Worm Gut	Four 14-Inch Sutures	00, 0, 1
450	White Twisted Silk	60 Inches	000, 00, 0, 1, 2, 3
460	Black Twisted Silk	60 Inches	000, 0, 2
480	White Braided Silk	60 Inches	00, 0, 2, 4
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812	10-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
822	20-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
862	Horsehair	Two 28-Inch Sutures	00
872	Plain Silk Worm Gut	Two 14-Inch Sutures	0
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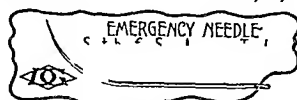
Sterilized by Heat After Closure of the Tubes

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914	10-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
924	20-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
964	Horsehair	Two 28-Inch Sutures	00
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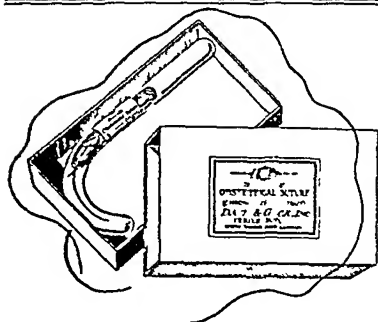
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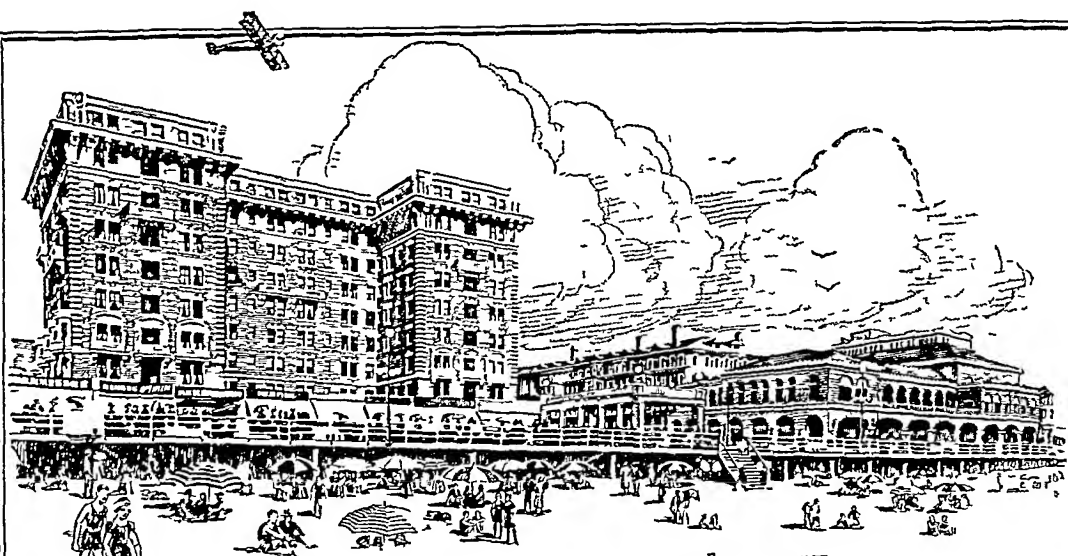
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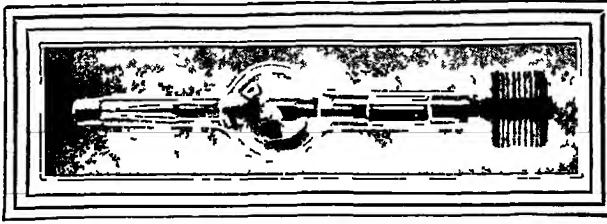
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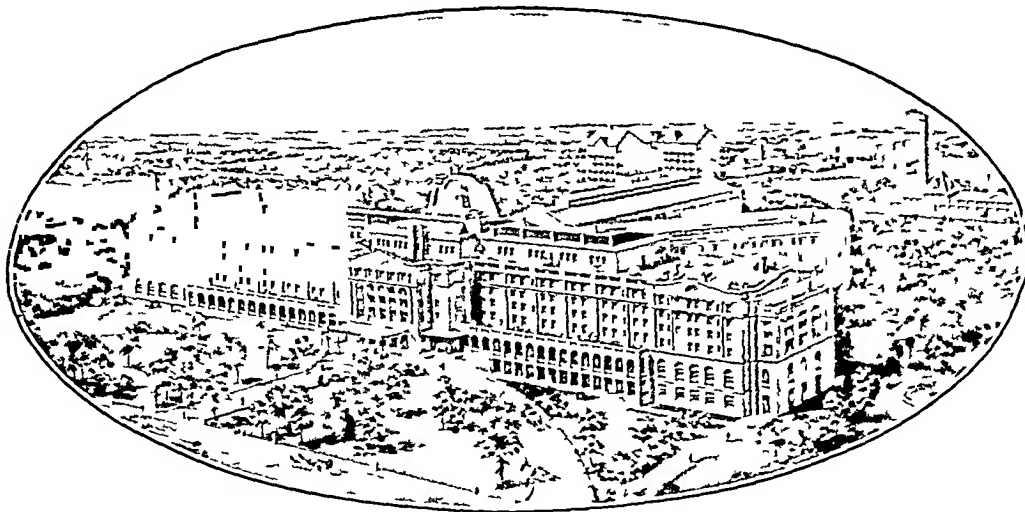
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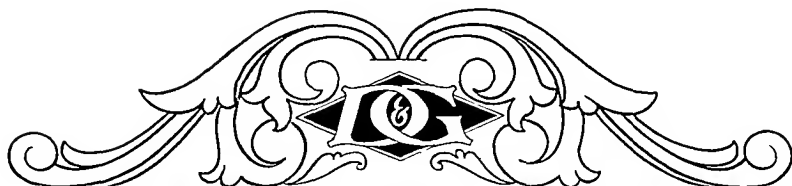
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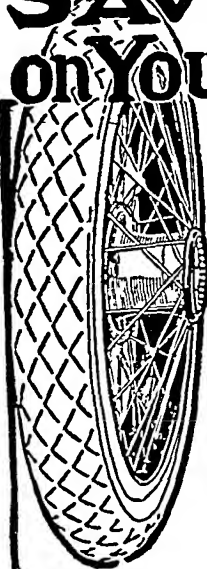


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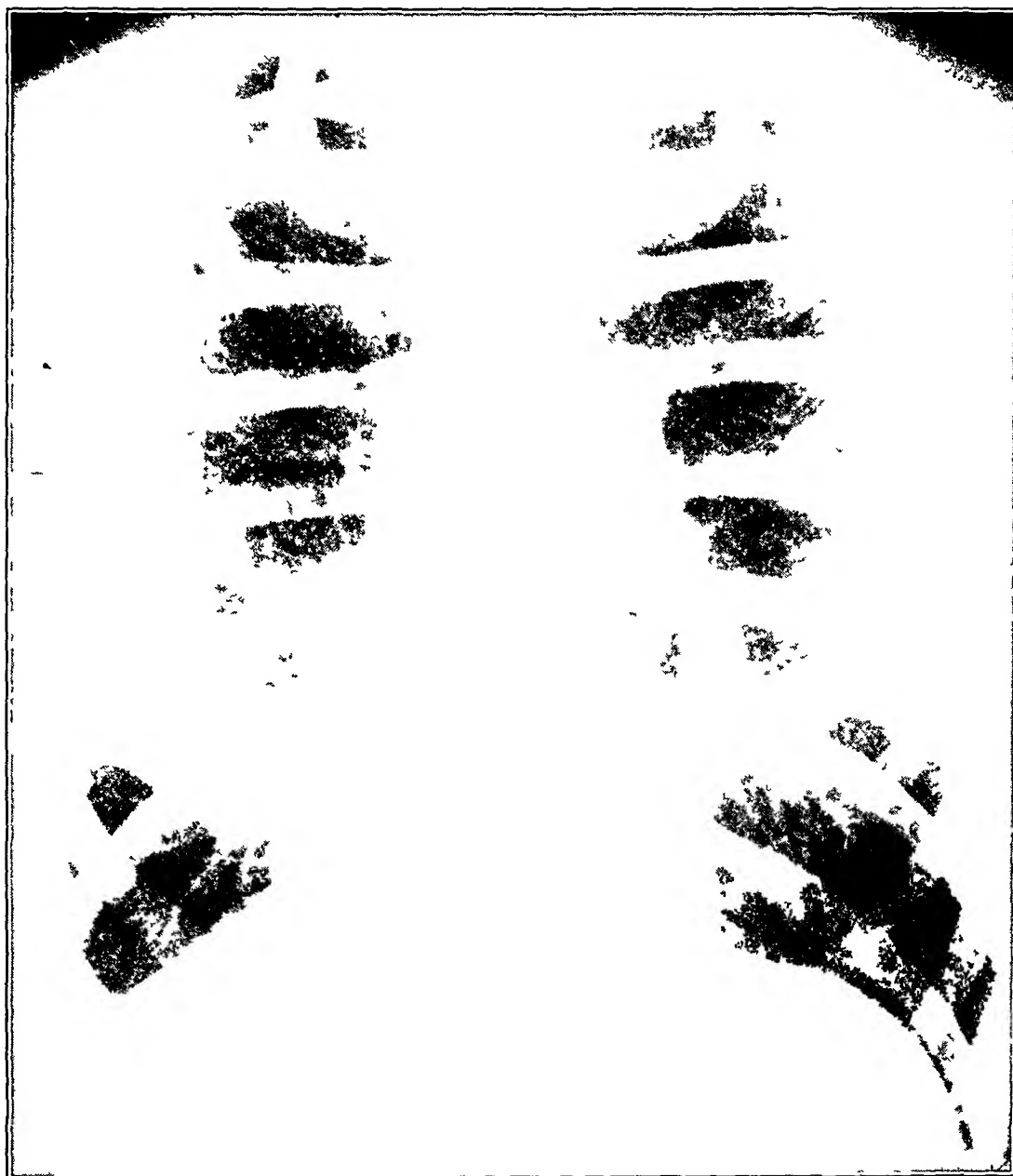
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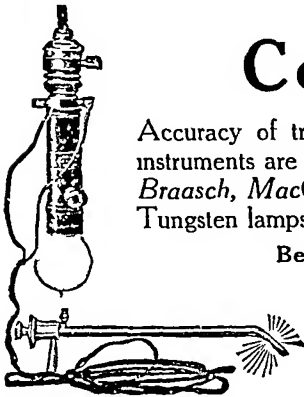
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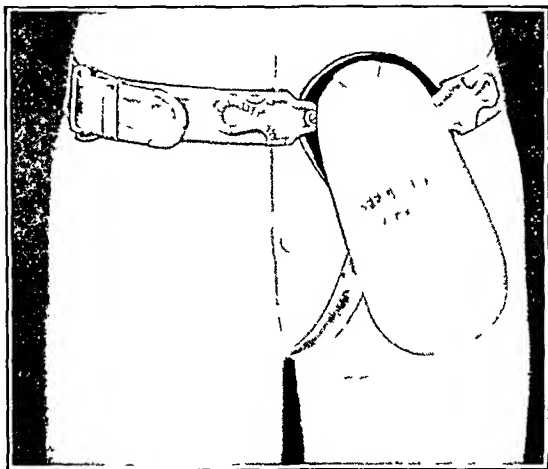


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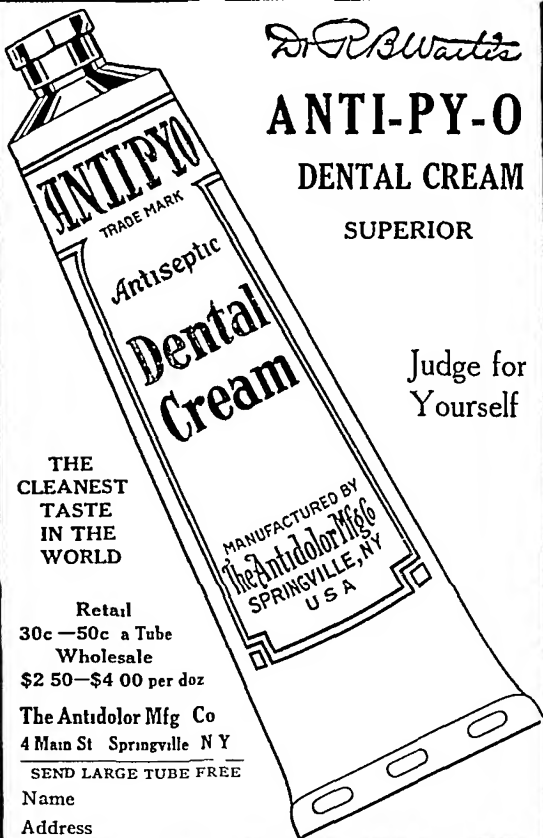
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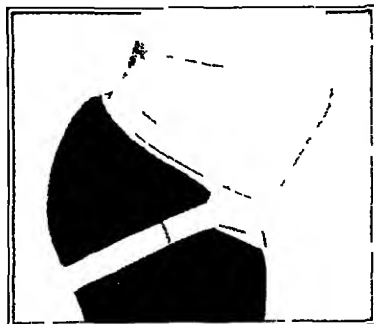
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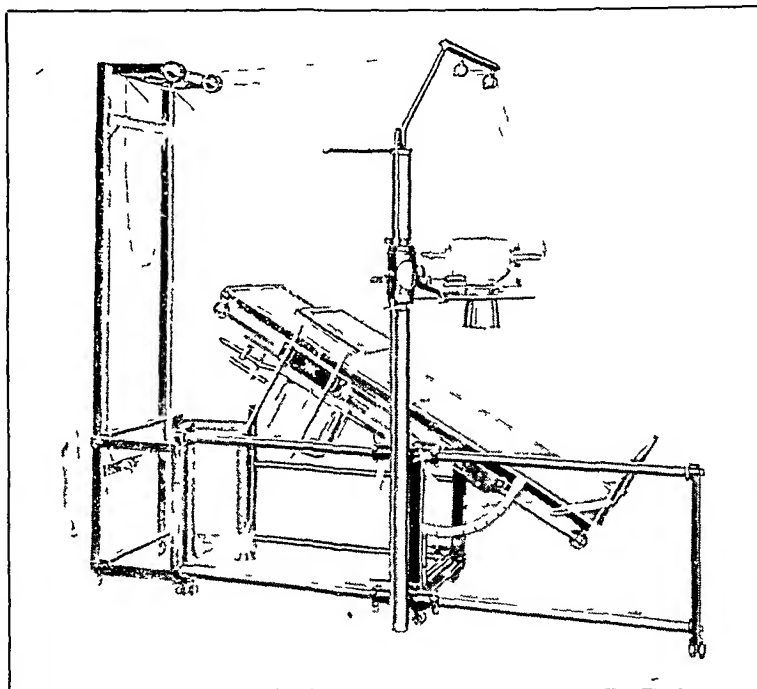
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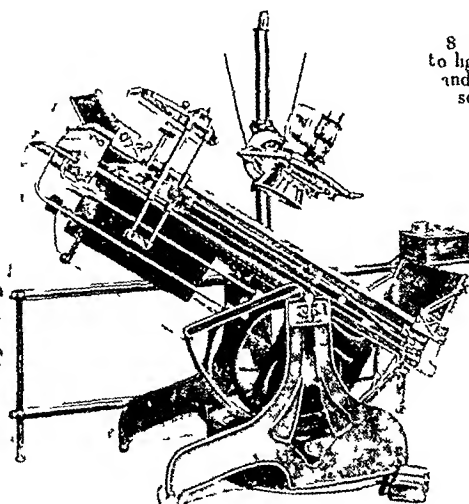
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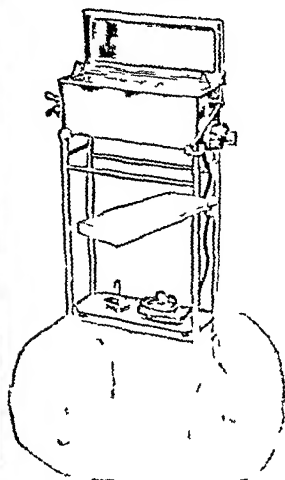
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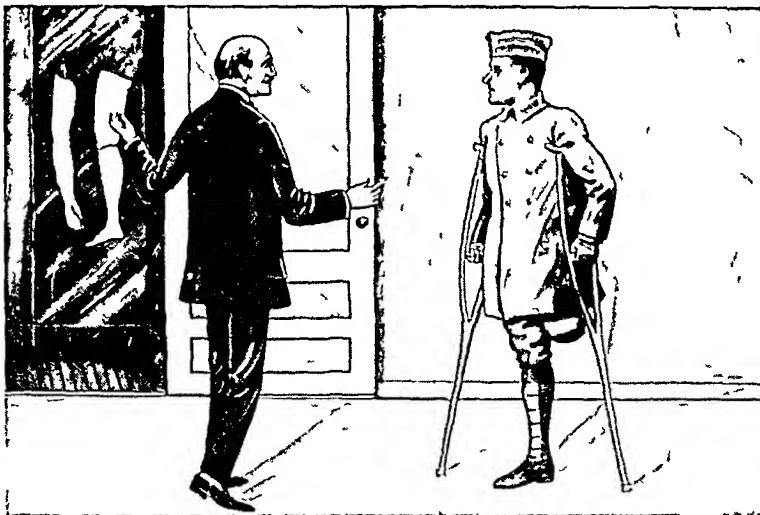
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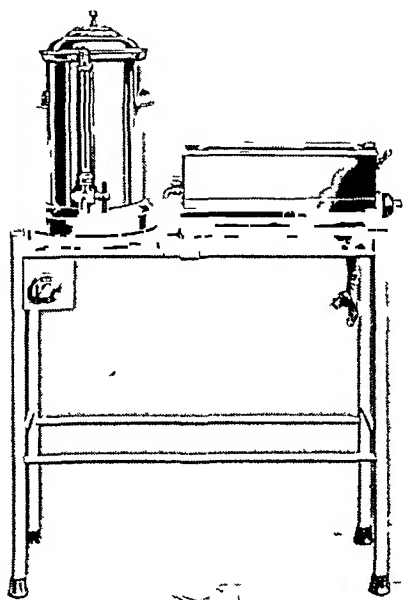
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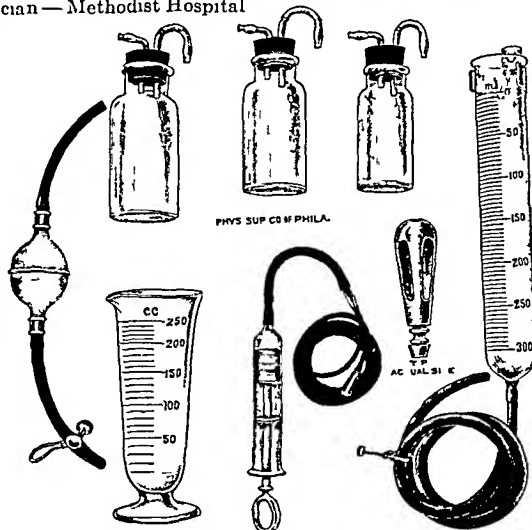
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The sealed tubes are submerged in a bath of cumol—the high boiling hydrocarbon. The temperature of the cumol bath is gradually elevated until at the end of six hours the maximum of 165°C (329° F) is reached. This temperature is maintained for five hours, and is then allowed to slowly decline. The temperature curve is graphically represented by the chart shown below.

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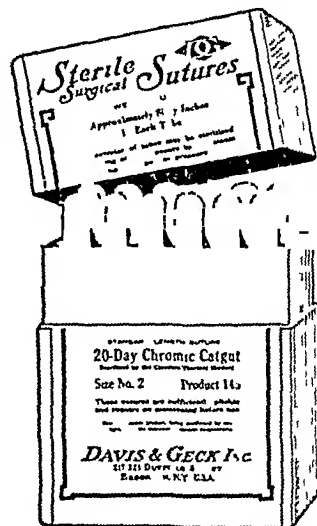
sutures but which were responsible for considerable wound irritation.

No other mode of sterilization so completely fulfills the exacting requirements for the production of ideal sutures as does the Claustro-Thermal method. Through its use the natural physical characteristics of the strands are preserved, while the destruction of all bacterial life is absolutely assured.

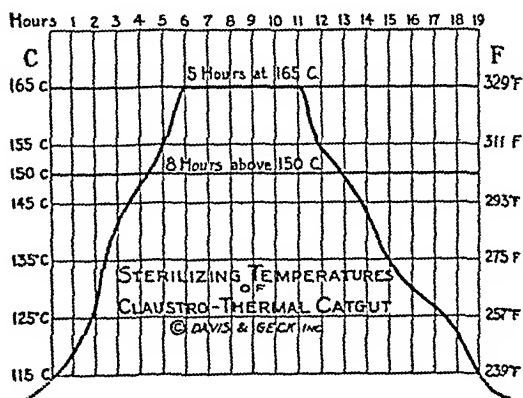
Claustro-Thermal sutures are not impregnated with any germicidal substance, and consequently they exert no bactericidal influence in the tissues.

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Standardized Sizes	0	2	4	6	8

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00	_____
0	_____
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2	_____
3	_____
4	_____
6	_____
8	_____

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862	Horsehair	Two 28-Inch Sutures	00
872	Plain Silkworm Gut	Two 14-Inch Sutures	0
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924	20-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
964	Horsehair	Two 28-Inch Sutures	00
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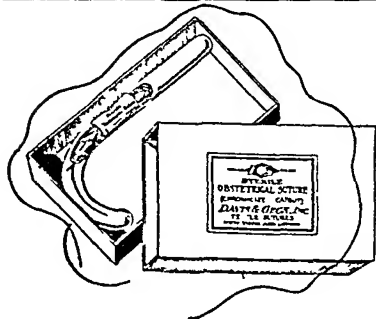
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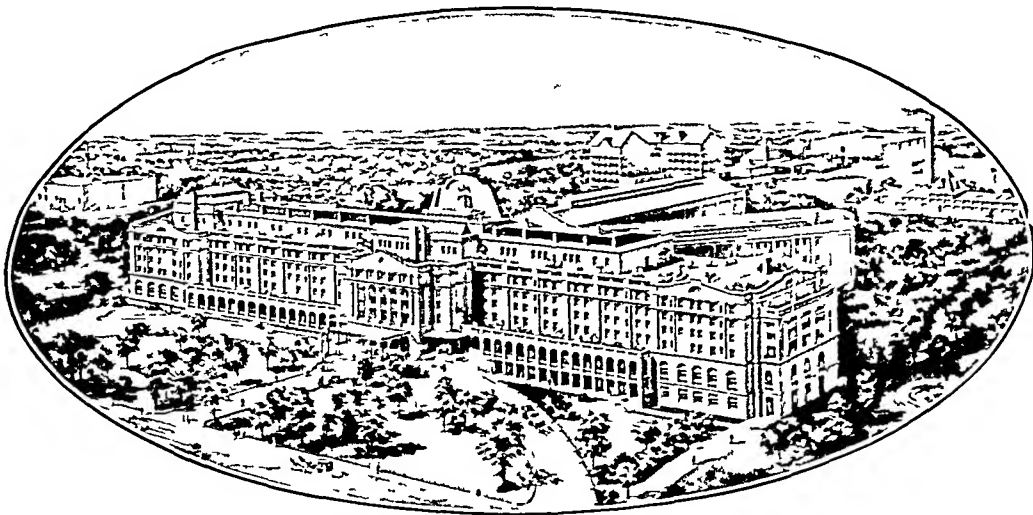
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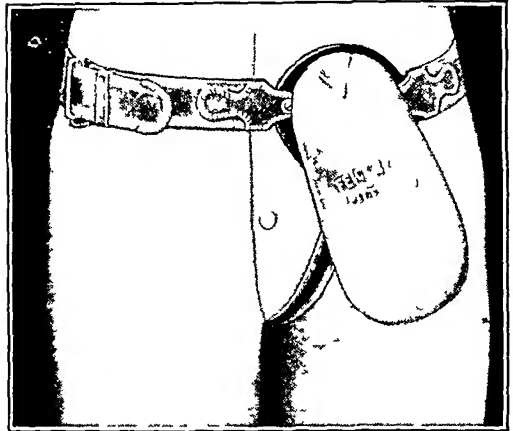


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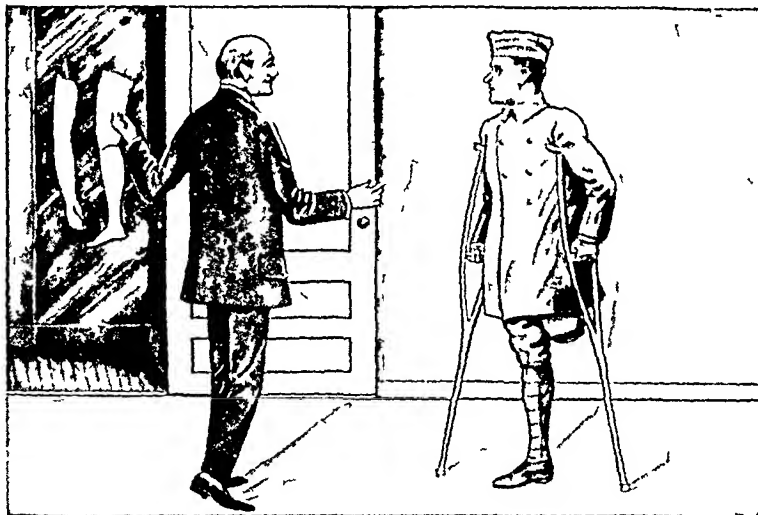
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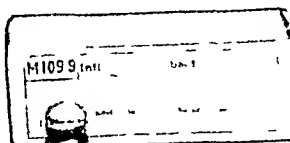
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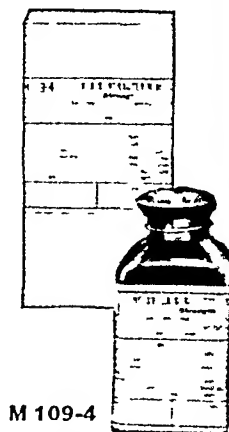
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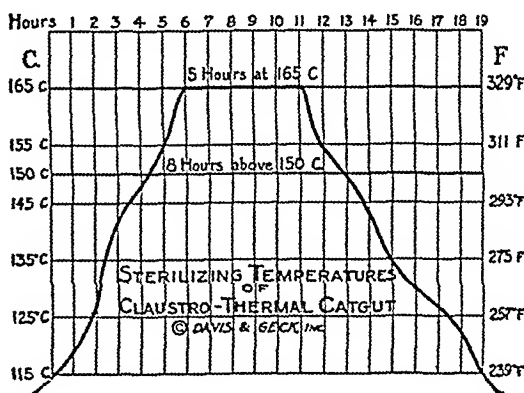
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00	_____
0	_____
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400	Black Silkworm Gut	Four 14-inch Sutures	00, 0, 1
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460	Black Twisted Silk	60 Inches	000, 0, 2
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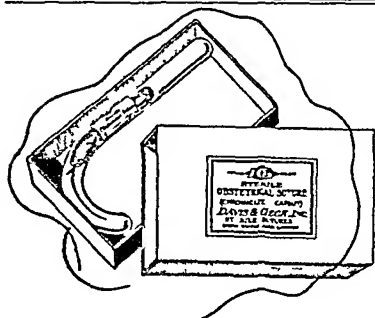
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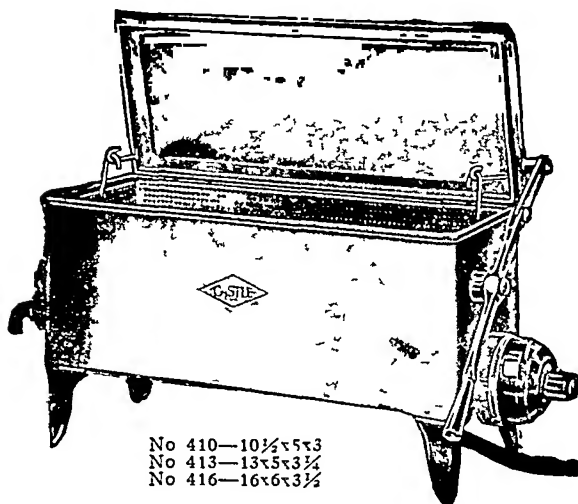
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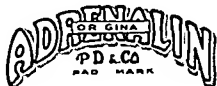
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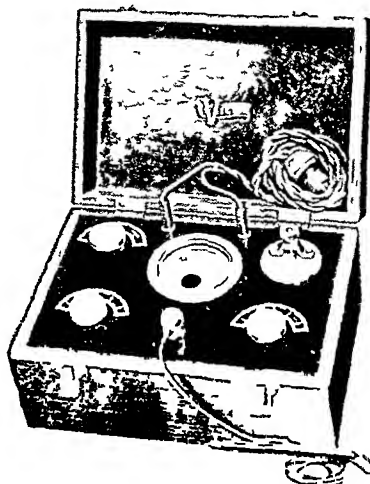
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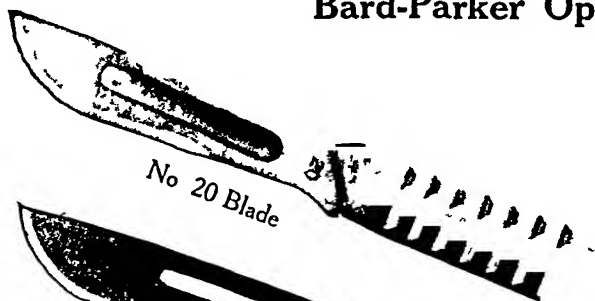
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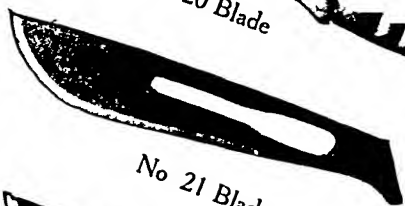
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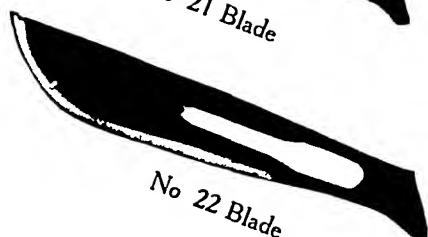
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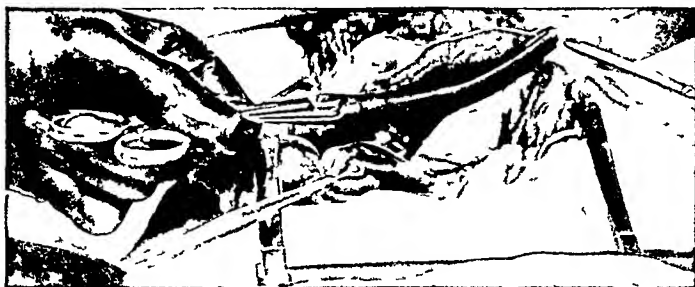
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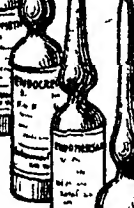
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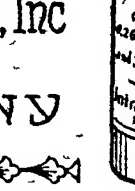
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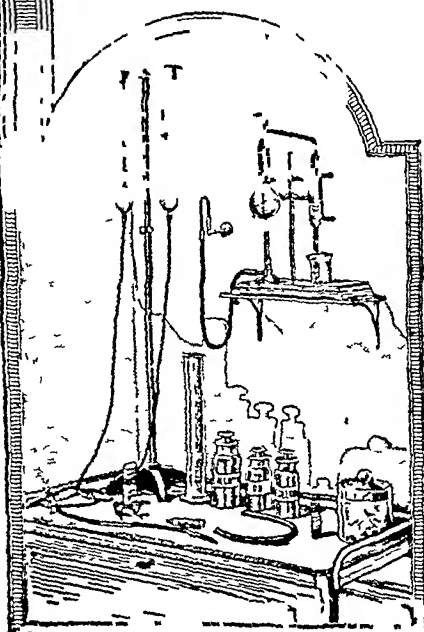
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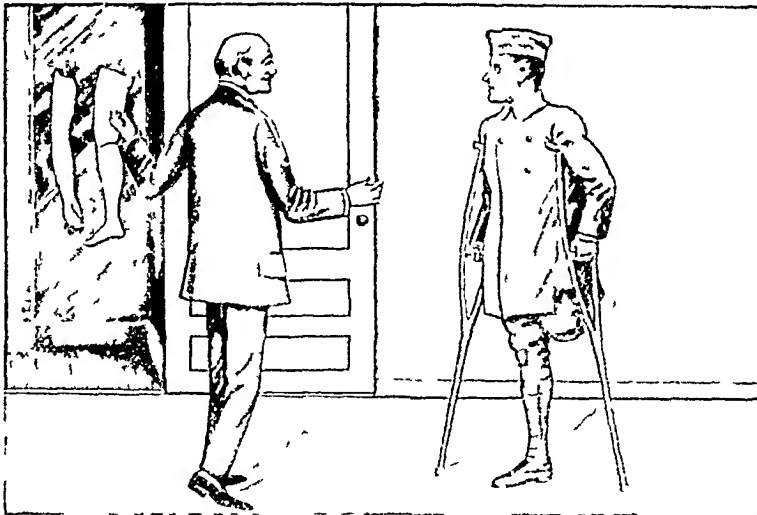
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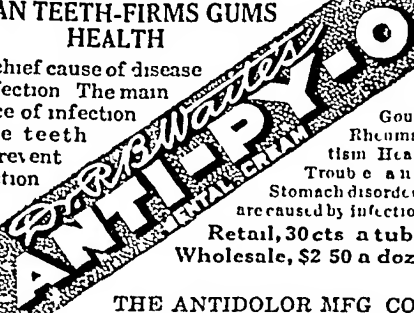


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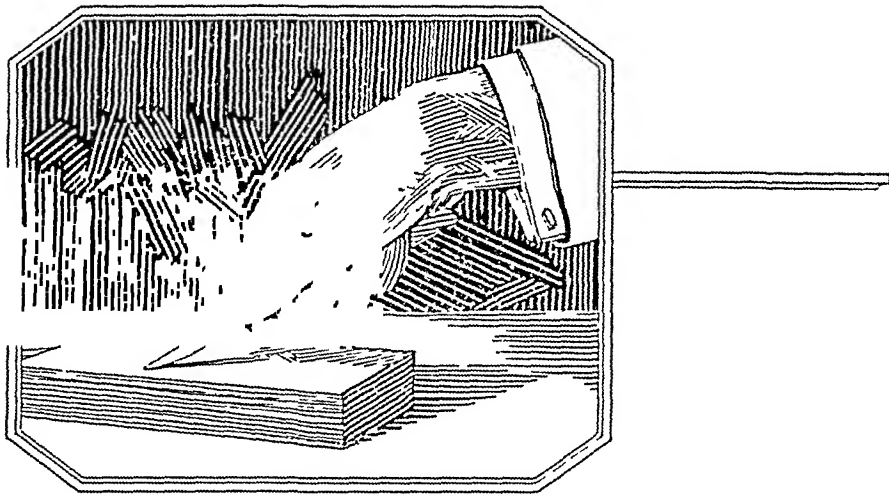
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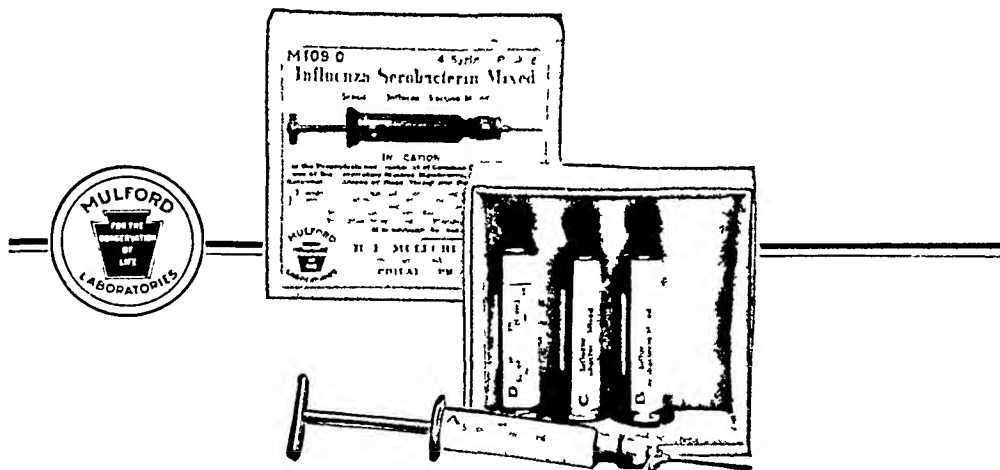
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Associate in Gynecology, University of Pennsylvania

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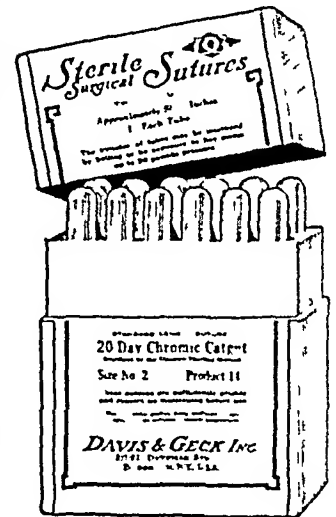
sutures but which were responsible for considerable wound irritation.

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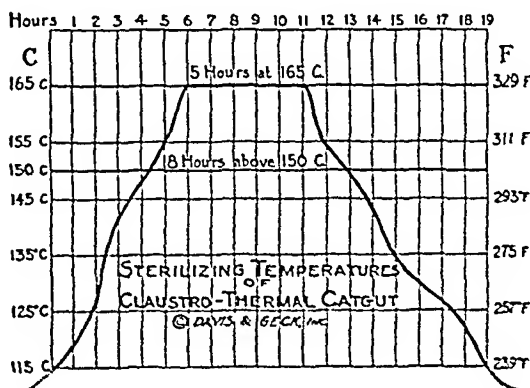
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00	_____
0	_____
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2	_____
3	_____
4	_____
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8	_____

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360	Horsehair	Four 28-Inch Sutures	00
390	Plain Silkworm Gut	Four 14-Inch Sutures	00, 0, 1
400	Black Silkworm Gut	Four 14-Inch Sutures	00, 0, 1
450	White Twisted Silk	60 Inches	000, 00, 0, 1, 2, 3
460	Black Twisted Silk	60 Inches	000, 0, 2
480	White Braided Silk	60 Inches	00, 0, 2, 4
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812	10-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
822	20-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
862	Horsehair	Two 28-Inch Sutures	00
872	Plain Silkworm Gut	Two 14-Inch Sutures	0
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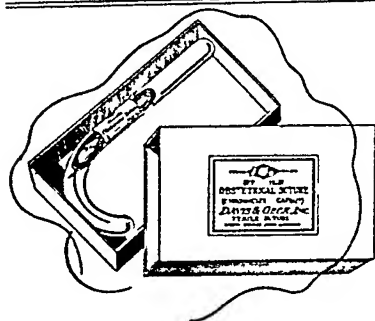
Sterilized by Heat After Closure of the Tubes

Product No	Material	Approximate Quantity in Each Tube	Catgut Sizes
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914	10-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
924	20-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
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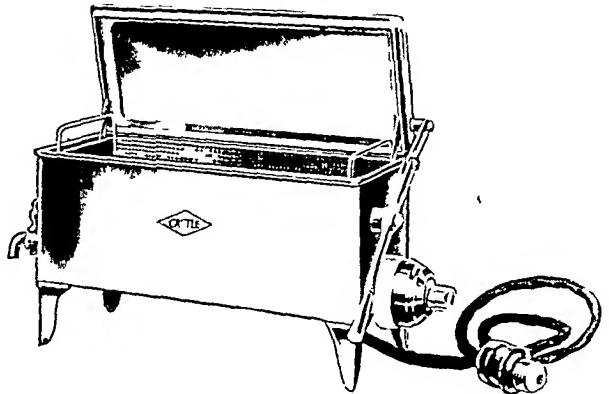
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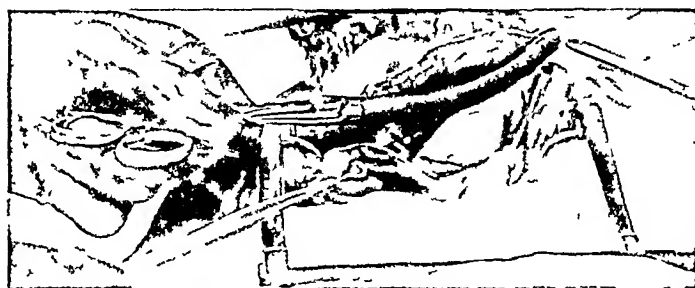
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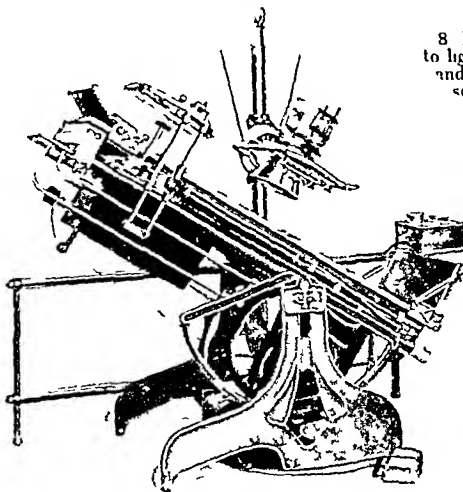
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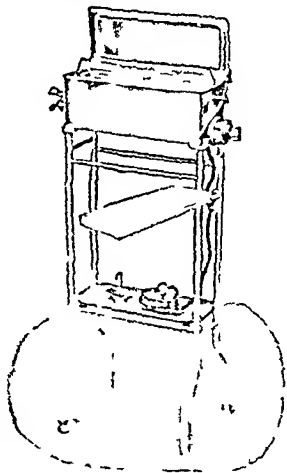
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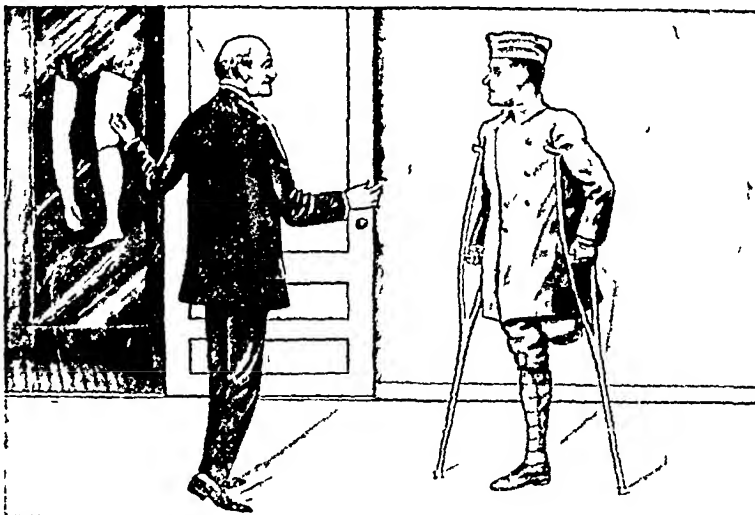
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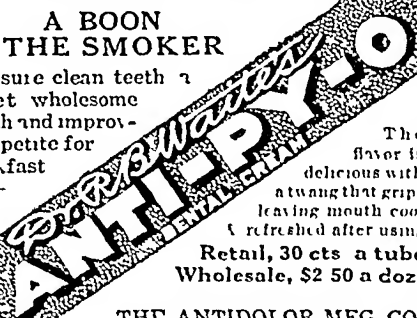
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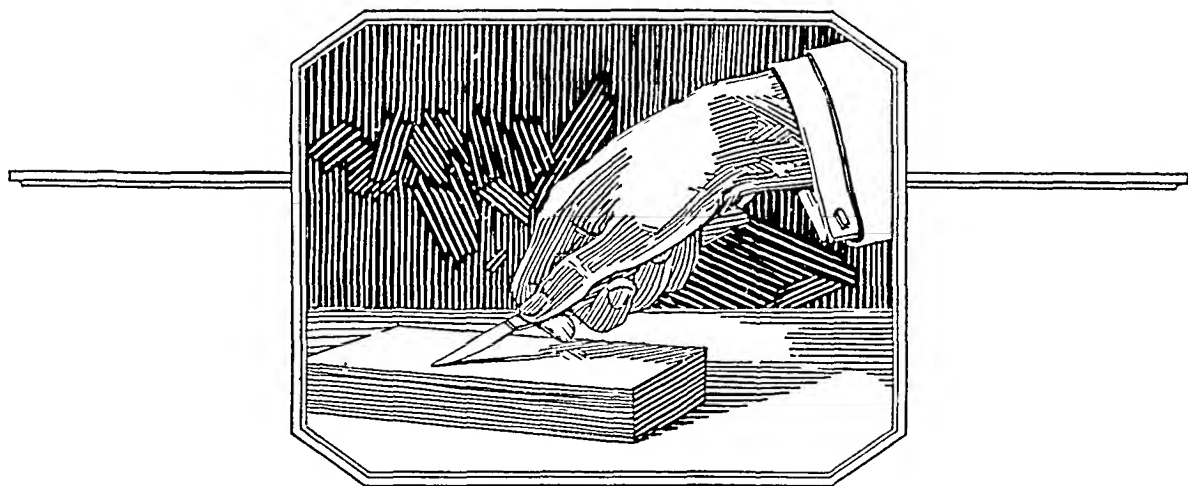
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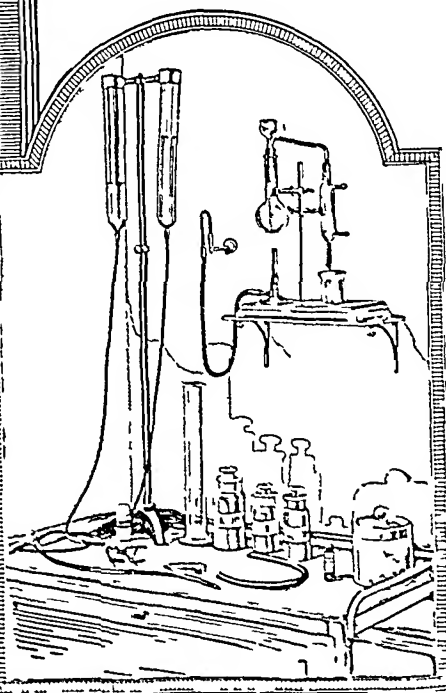
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The work is most comprehensive, and deals in a highly instructive way not only with diseases of women, but also with those coincident renal and abdominal lesions that are frequently encountered in the course of gynecologic affections

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Boilable

CLAUSTRO-THERMAL, meaning *enclosed heat*, is descriptive of the improved method of heat sterilization. The principle of the method consists in applying the heat after closure of the tubes, thus avoiding all the chances of accidental contamination.

The sealed tubes are submerged in a bath of cumol—the high boiling hydrocarbon. The temperature of the cumol bath is gradually elevated until at the end of six hours the maximum of 165° C (329° F) is reached. This temperature is maintained for five hours, and is then allowed to slowly decline. The temperature curve is graphically represented by the chart shown below.

It is obvious, therefore, that sterility is absolutely assured. The sutures, being stored in their original tubing fluid and reaching the surgeon's hands sealed within the tubes in which they were sterilized, are removed from all the chances of contamination incident to the customary method of sterilizing the strands in open tubes.

Sterilization by this integral method is made feasible through the use of toluol as the tubing fluid. The discovery of the value of toluol for this purpose was the outcome of an investigation aimed at finding a suitable fluid to replace chloroform. The latter was formerly in general use, but was unsatisfactory because it was found to break down into chemical products which not only exerted an extremely harmful action on the collagen of the

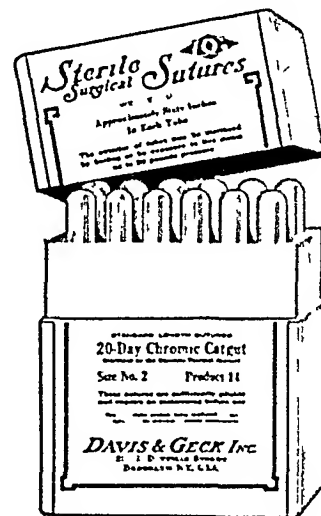
sutures but which were responsible for considerable wound irritation.

No other mode of sterilization so completely fulfills the exacting requirements for the production of ideal sutures as does the Claustro-Thermal method. Through its use the natural physical characteristics of the strands are preserved, while the destruction of all bacterial life is absolutely assured.

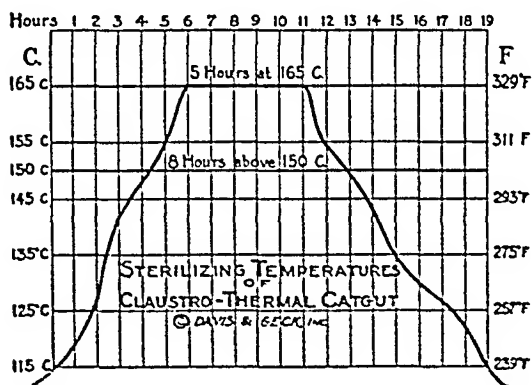
Claustro-Thermal sutures are not impregnated with any germicidal substance, and consequently they exert no bactericidal influence in the tissues.

This product embodies all the essentials of the perfect suture, such as compatibility with tissues, accuracy of size, maximum tensile strength, perfect and dependable absorbability, and absolute sterility.

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An Improved Germicidal Suture Superseding Iodized Catgut

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The older practise of impregnating catgut with the ordinary crystalline iodine for this purpose was at best an unsatisfactory method, since the antiseptic power was but slight and transient. The most serious deficiencies of such iodized sutures, however, were their instability and weakness arising from exposure to light, the deterioration resulting from the continuous and unpreventable oxidizing action of the iodine, and the disintegration of the sutures when heated. Moreover, the decomposition products of iodine caused such sutures to be irritating.

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Kalmerid catgut, in addition to its bactericidal attribute, embodies all the essentials of the perfect suture. It is perfectly compatible with the tissues, its absorbability is dependable, and its tensile strength is particularly good.

TWO VARIETIES—To meet the requirements of different surgeons two kinds of Kalmerid catgut are prepared—the boilable, and non-boilable.

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They are genuine kangaroo tendons, they are round, smooth, straight, of uniform contour, and possess a tensile strength about twice that of the best catgut of equivalent size.

Because of their greater strength some surgeons prefer these tendons to catgut, particularly in the finer sizes, for general intestinal, muscle, fascia, and skin suturing.

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or in tendon for approximately thirty days. Shortly after that period the sutures, with their knots, will be completely absorbed.

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The **NON-BOILABLE** tendons are extremely pliable and consequently require no moistening.

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Before immersion, the toluol, which is very volatile, should be allowed to evaporate so that the water may have access to the sutures.

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~ Sizes ~

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Standardized Sizes	0	2	4	6	8

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00	_____
0	_____
1	_____
2	_____
3	_____
4	_____
6	_____
8	_____

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360 Horsehair	Four 28-Inch Sutures	00
390 Plain Silkworm Gut	Four 14-Inch Sutures	00, 0, 1
400 Black Silkworm Gut	Four 14-Inch Sutures	00, 0, 1
450 White Twisted Silk	60 Inches	000, 00, 0, 1, 2, 3
460 Black Twisted Silk	60 Inches	000, 0, 2
480 White Braided Silk	60 Inches	00, 0, 2, 4
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812 10-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
822 20-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
862 Horsehair	Two 28-Inch Sutures	00
872 Plain Silkworm Gut	Two 14-Inch Sutures	0
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With Needles

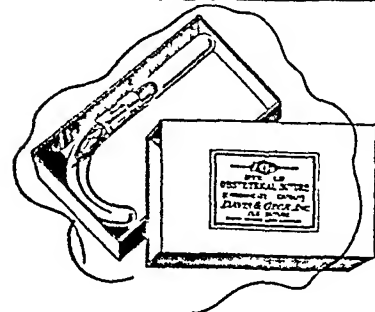
Sterilized by Heat After Closure of the Tubes

Product No	Approximate Quantity in Each Tube	Standardized Sizes
904 Plain Catgut	20 Inches	00, 0, 1, 2, 3
914 10-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
924 20-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
964 Horsehair	Two 28-Inch Sutures	00
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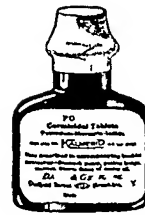
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Needles correspond to Suture Sizes

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Iodine
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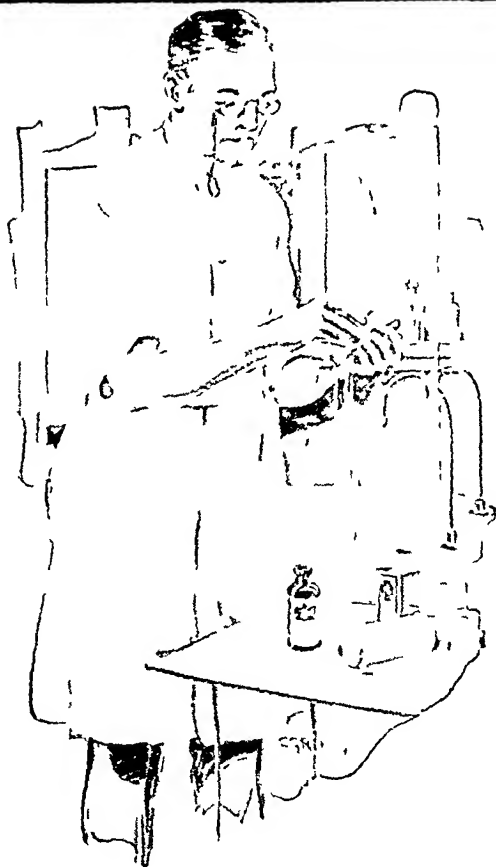
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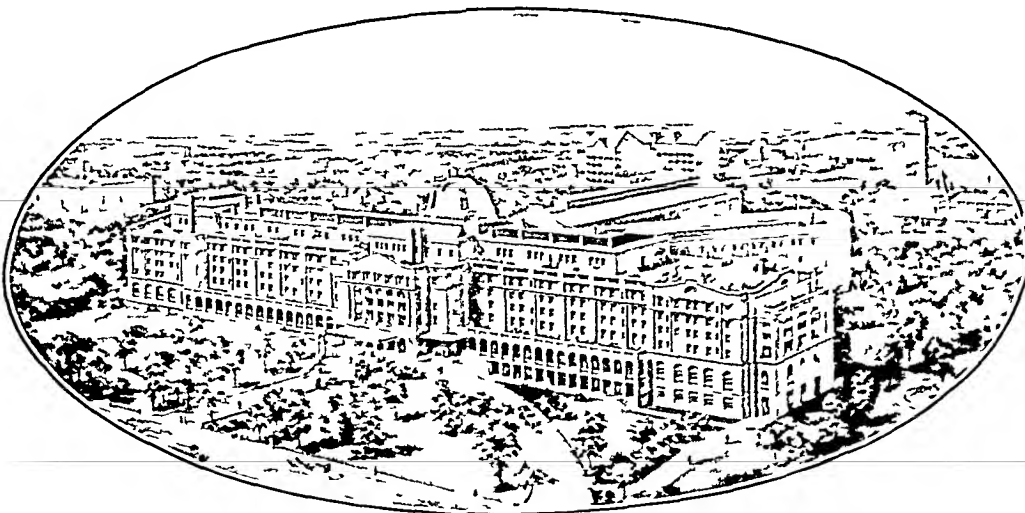
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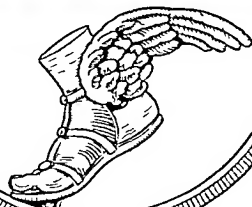


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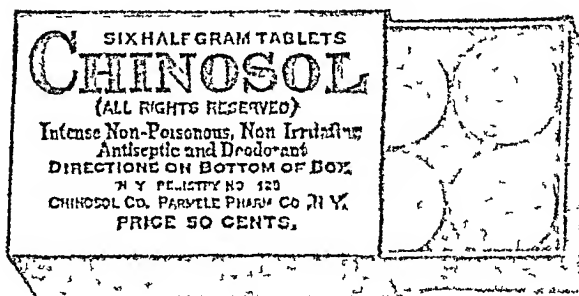
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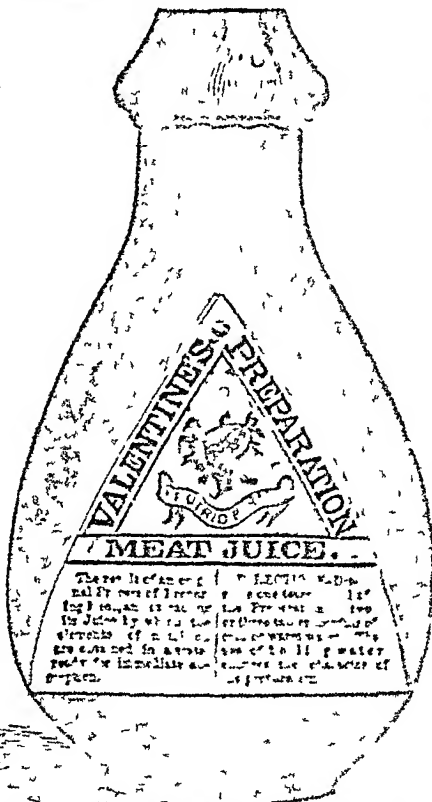
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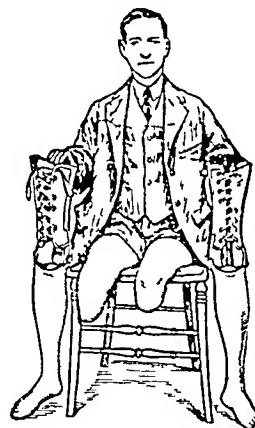
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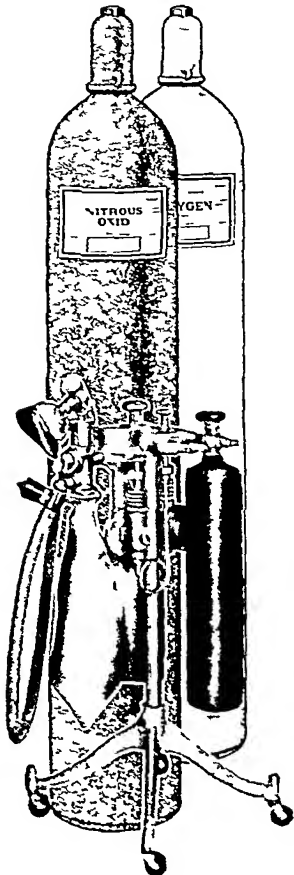
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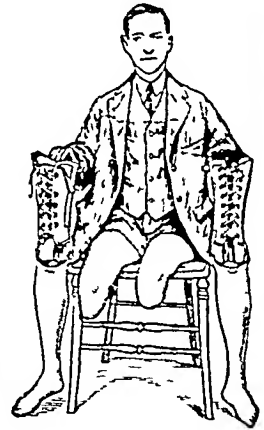
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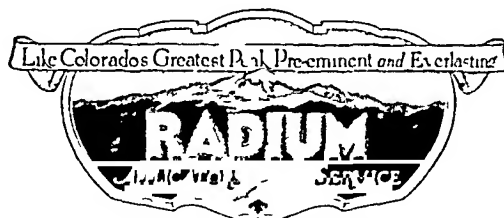
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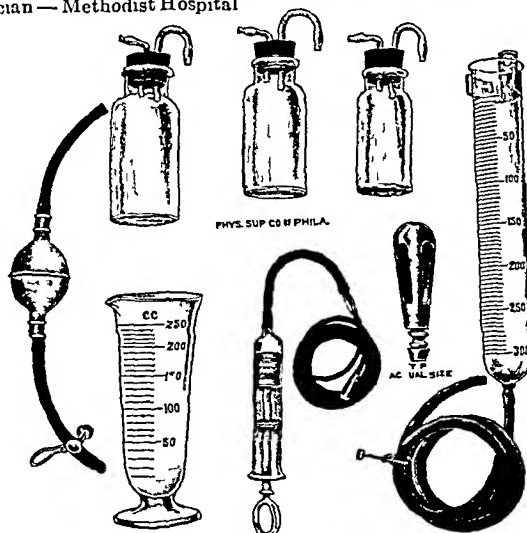
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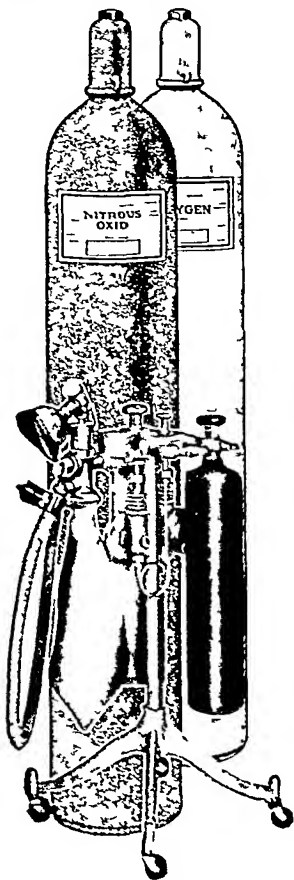
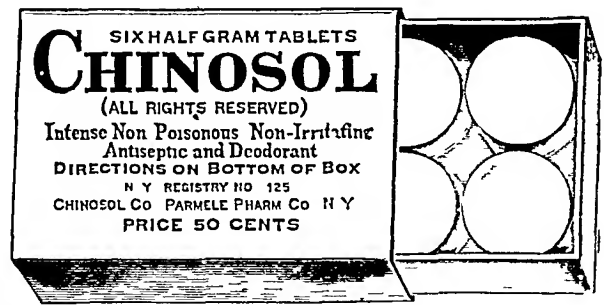
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Boilable

CLAUSTRO-THERMAL, meaning *enclosed heat*, is descriptive of the improved method of heat sterilization The principle of the method consists in applying the heat after closure of the tubes, thus avoiding all the chances of accidental contamination

The sealed tubes are submerged in a bath of cumol—the high boiling hydrocarbon The temperature of the cumol bath is gradually elevated until at the end of six hours the maximum of 165° C (329° F) is reached This temperature is maintained for five hours, and is then allowed to slowly decline The temperature curve is graphically represented by the chart shown below

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Sterilization by this integral method is made feasible through the use of toluol as the tubing fluid The discovery of the value of toluol for this purpose was the outcome of an investigation aimed at finding a suitable fluid to replace chloroform The latter was formerly in general use, but was unsatisfactory because it was found to break down into chemical products which not only exerted an extremely harmful action on the collagen of the

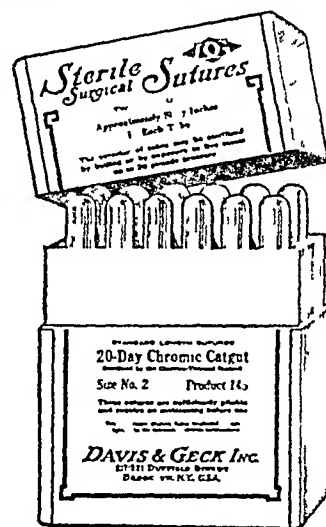
sutures but which were responsible for considerable wound irritation

No other mode of sterilization so completely fulfills the exacting requirements for the production of ideal sutures as does the Claustro-Thermal method Through its use the natural physical characteristics of the strands are preserved, while the destruction of all bacterial life is absolutely assured

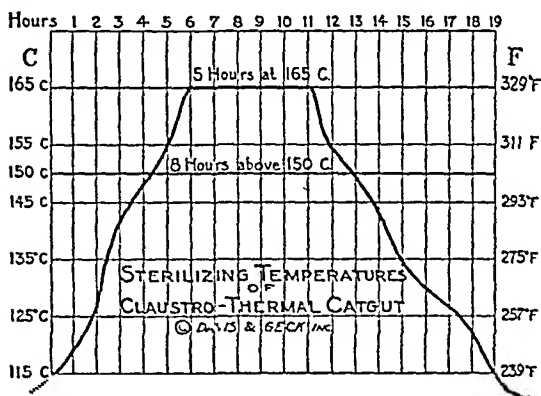
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See Advertisement on Page 16

CONTINUED

Kalmerid Catgut

An Improved Germicidal Suture Superseding Iodized Catgut

KALMERID CATGUT is not only sterile, but, being impregnated with potassium-mercuric-iodide—a double iodine compound—the sutures exert a local bactericidal action in the tissues

The older practise of impregnating catgut with the ordinary crystalline iodine for this purpose is at best an unsatisfactory method, since the antiseptic power is but slight and transient. The most serious deficiencies of such iodized sutures, however, are their instability and weakness arising from exposure to light, the deterioration resulting from the continuous and unpreventable oxidizing action of the iodine, and the disintegration of the sutures when heated. Moreover, the decomposition products of iodine cause such sutures to be irritating.

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Because of their greater strength some surgeons prefer these tendons to catgut, particularly in the finer sizes, for general intestinal, muscle, fascia, and skin suturing.

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The Non-Boilable Grade is *Product No 370*

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Former Tendon Sizes	Ex Fine	Fine	Medium	Coarse	Ex Coarse

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00	_____
0	_____
1	_____
2	_____
3	_____
4	_____
6	_____
8	_____

Standardized Sizes

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IN conformity with the long recognized need for a unified system of sizes, the standard metric catgut scale has been extended to embrace all sutures, including kangaroo tendons, silk, horsehair, silkworm gut, and celluloid-linen thread.

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360	Horsehair	Four 28-Inch Sutures	00
390	Plain Silkworm Gut	Four 14-Inch Sutures	00, 0, 1
400	Black Silkworm Gut	Four 14-Inch Sutures	00, 0, 1
450	White Twisted Silk	60 Inches	000, 00, 0, 1, 2, 3
460	Black Twisted Silk	60 Inches	000, 0, 2
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812	10-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
822	20-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
862	Horsehair	Two 28-Inch Sutures	00
872	Plain Silkworm Gut	Two 14-Inch Sutures	0
882	White Twisted Silk	20 Inches	000, 0, 2
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914	10-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
924	20-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
964	Horsehair	Two 28-Inch Sutures	00
974	Plain Silkworm Gut	Two 14-Inch Sutures	0
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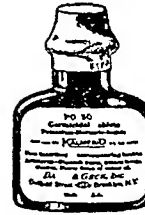
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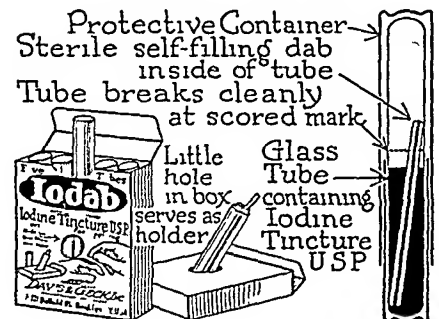
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"BRIDGING THE GAP"

A FORWARD STEP

For the sole purpose of establishing a closer relationship with the foreign language publications our Managing Editor has spent the last two months in visiting European medical centers to arrange for the more prompt and accurate abstracting of foreign medical literature.

Sub-offices are now maintained also in Naples, Madrid and Vienna, where the abstracts are being made in their native tongue by Italian, Spanish and German medical abstractors. The French articles are dealt with similarly in Paris.

Then, our previously trained staff makes over these abstracts into English, and they will reach New York as quickly as (sometimes before) the foreign medical journals get there. Thus, the gap between the date of an article and its appearance in abstract form in our monthly Survey will be bridged, and our subscribers will appreciate the efforts made in their interest.

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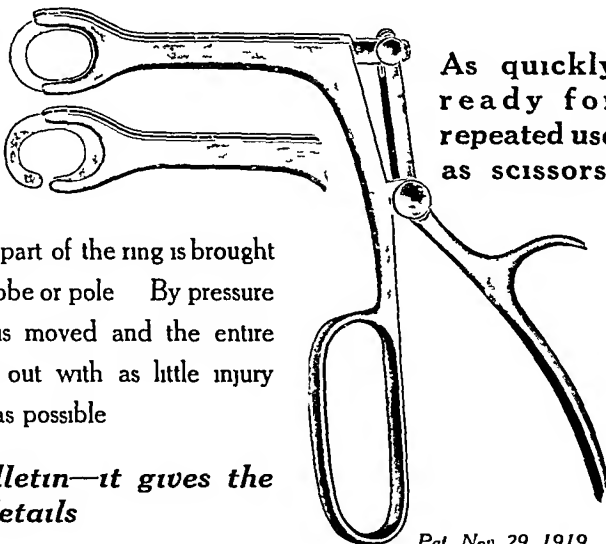
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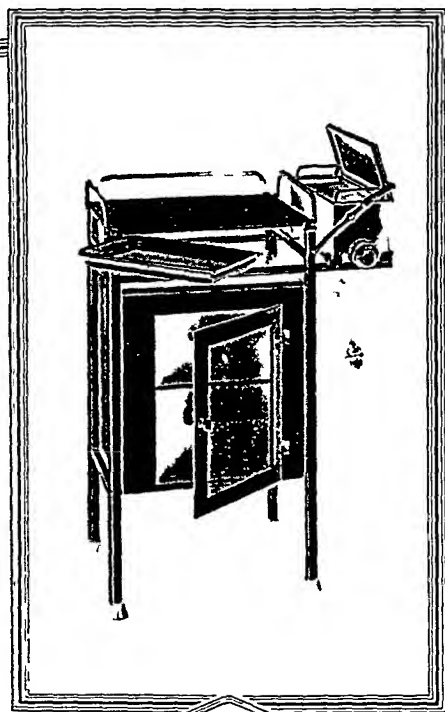
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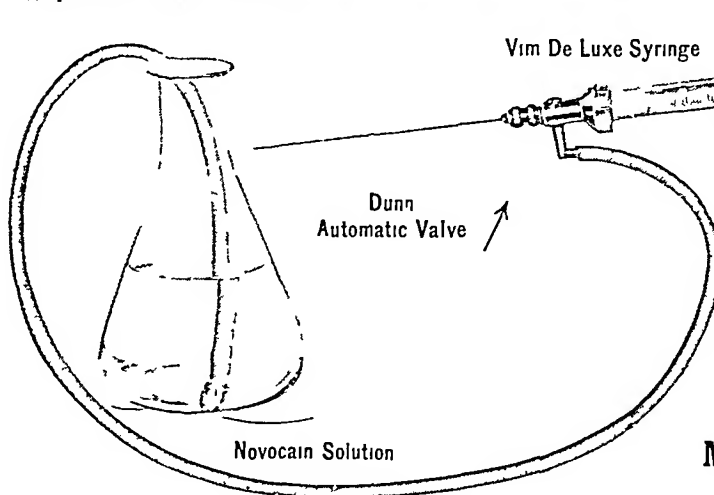
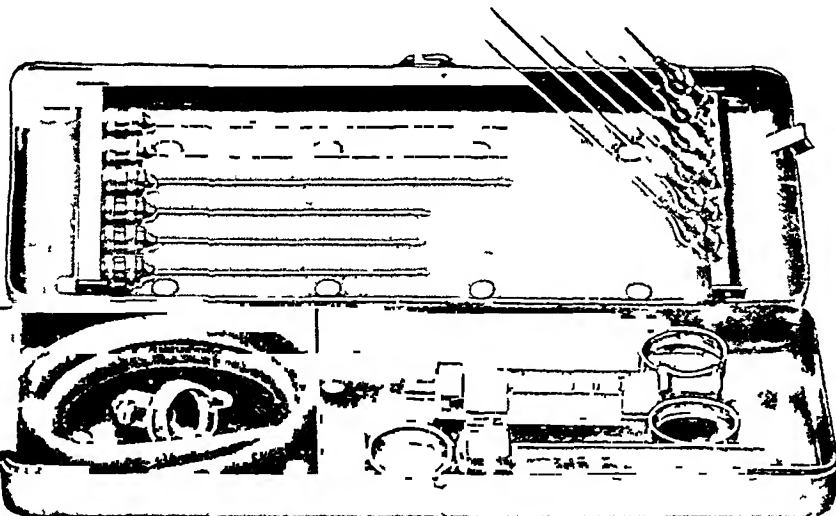
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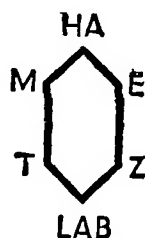
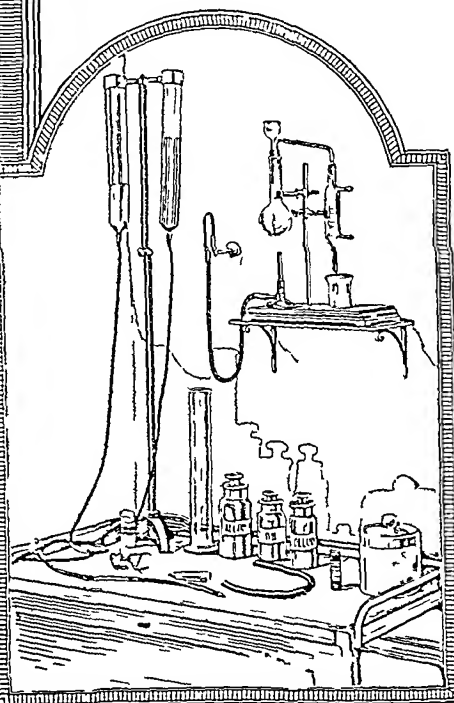
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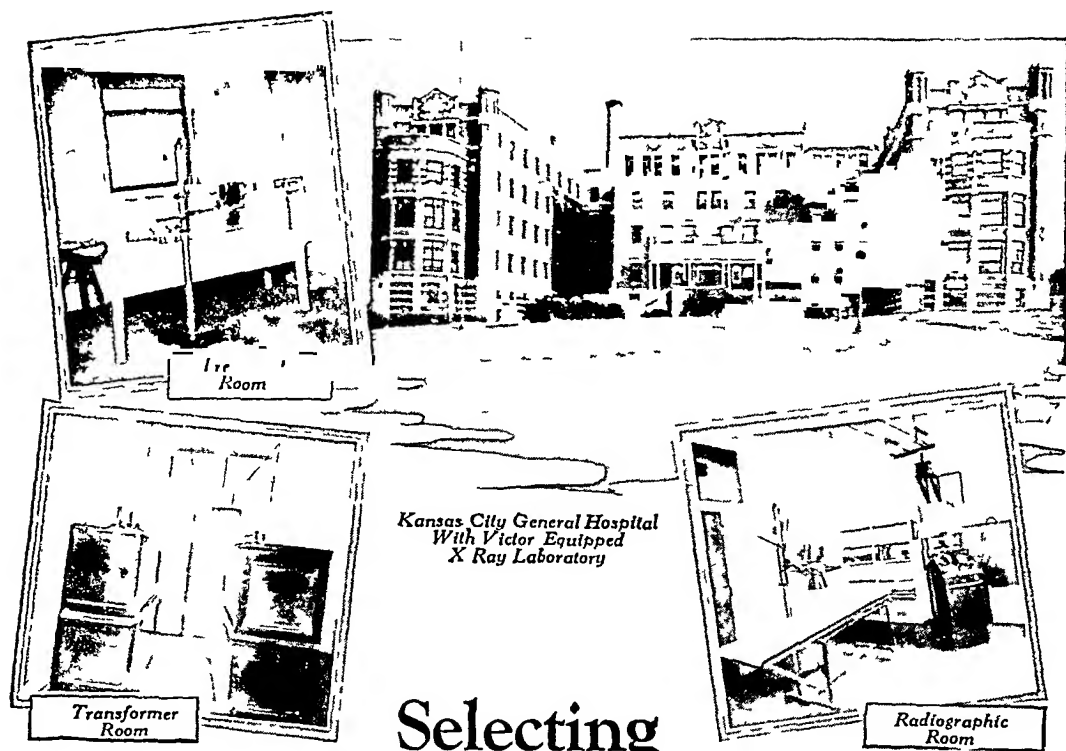
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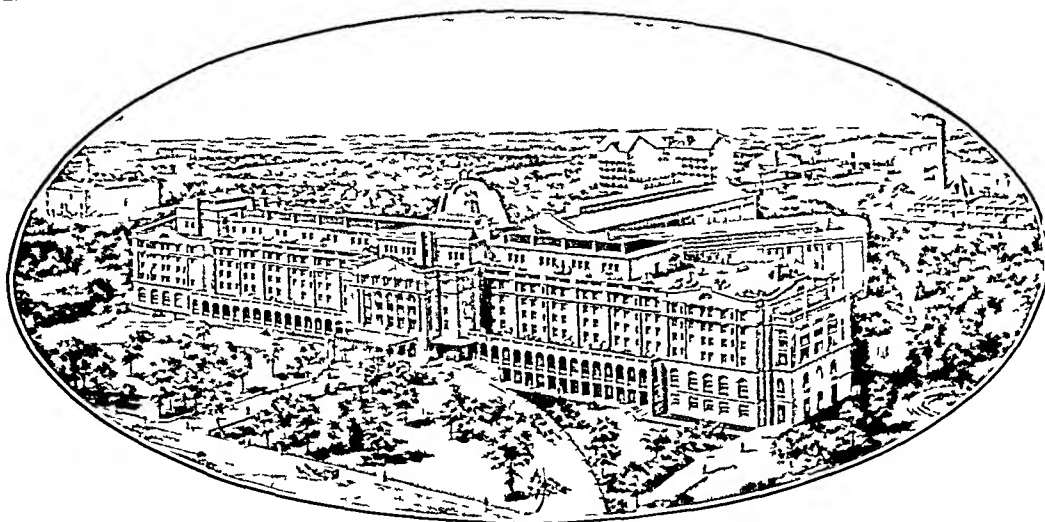
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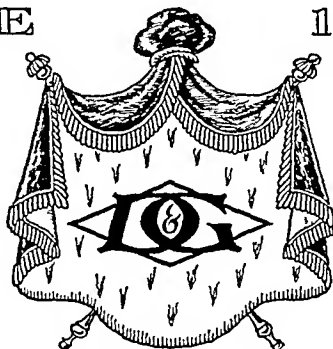
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No 1

NEW MECHANICAL PROBLEMS IN THE BRONCHOSCOPIC EXTRACTION OF FOREIGN BODIES FROM THE LUNGS AND ŒSOPHAGUS

BY CHEVALIER JACKSON, M D
OF PHILADELPHIA, PA

IN the early days of bronchoscopy and œsophagoscopy no thought was given to the matter or the mechanical problems of the disentanglement, disimpaction or version of foreign bodies. The whole art of endoscopy was thought to consist of introduction of the instruments. This was considered a formidable task. One text-book stated in effect that if the bronchoscope could not be introduced through the mouth in fifteen minutes a tracheotomy should be done for the introduction of the bronchoscope through the neck. To-day, anyone who has been taught a proper technic, and who has instruments proper for the particular patient, should insert the bronchoscope in less than a minute. In the early days referred to, when the foreign body was seen, forceps were introduced, the foreign body was seized often along with tissues, and the foreign body was ruthlessly torn out at all hazards. In 1914 the author¹ called attention to the necessity of a careful study of the mechanical problems of foreign body disentanglement and removal and illustrated the general mechanical principles he had applied to the extraction of a large variety of foreign bodies. These were added to in subsequent publications² and³. Since then there have come to the Bronchoscopic Clinic so many different varieties of foreign bodies that now, with a total experience of 891 foreign bodies in the air and food passages, I am able to present additional data that will, I venture to think, place the matter on a scientific basis. By this I mean only a basis, future developments doubtless will make present attainments appear embryonic. It will, however, always hereafter be regarded as fundamental that (1) A foreign body usually presents a mechanical problem of disengagement, disentanglement, version, method and location of seizure, etc., which must be worked out if low mortality and close to 100 per cent of successes is to be attained, and (2) conversely, grasping the first part of the foreign body seen and ruthlessly tearing it out is brutal and conscienceless, and will inevitably give a low percentage of successes and a high mortality ratio.

Movements of the Bronchi—In dealing with the problems of foreign-body extraction due consideration must be given to the bronchial movements, not only because of their increasing the difficulties in certain instances, but even more because of the invaluable aid they render to the bronchoscopist who waits and watches for the advantageous phases of their movements, as herein mentioned in connection with forceps spaces. The shortening during cough is also of advantage in protruding slender bodies that are completely within small branch bronchi, too small to enter, as first pointed out by the author.²



FIG 1.—Cartridge primer in left bronchus of a boy aged 7 years. The mucosa had swollen proximally until it presented the problem the solution of which is illustrated in Fig 2. Plate made by Dr Willis F Manges.

The movements of the tracheobronchial tree, as I have observed them bronchoscopically, may be categorically enumerated as follows:

- 1 Expansion during inspiration
- 2 Collapsing during expiration, almost all of the collapsing excursion being at the beginning of the expiratory phase
- 3 Elongation during inspiration
- 4 Shortening during expiration

BRONCHOSCOPIC EXTRACTION OF FOREIGN BODIES

5 Excessive contraction in one, many or all diameters during cough Sometimes in children this bechic contraction is sufficient to obliterate the bronchial lumen In the trachea of children the posterior (membranous) wall is at times projected forward convexly into the tracheal lumen

6 Excessive shortening during cough

7 Displacive movements in various directions, but chiefly sidewise, caused by the movements of adjacent viscera, chiefly the heart and great vessels, but in some instances by the opposite lung

It must be remembered, that, though here listed separately for clearness, two or more of the bronchial movements are often combined, as elsewhere mentioned²

Education of the Eye and the Fingers—Nothing will take the place of work with the eye at the tube The gauging of depth comes only slowly by dint

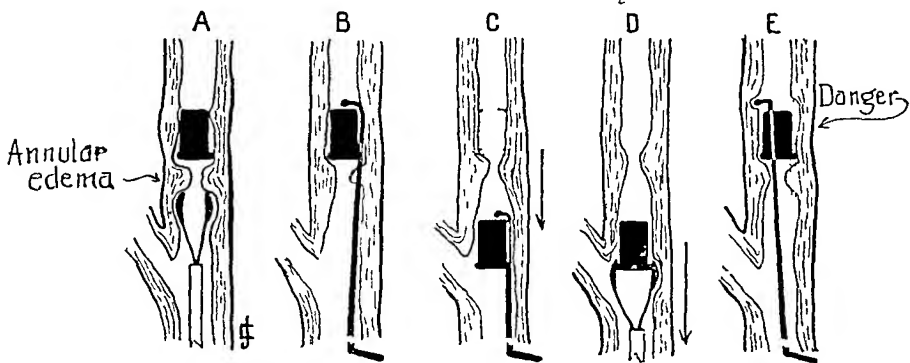


FIG 2—How a special probe-ended hook was used to withdraw the primer cap shown in Fig 1 to a higher, hence wider location in the bronchus so forceps could be applied Removal required 18 minutes and 33 seconds (Case No Fdby 841) At A is shown the impossibility of applying forceps because of the proximal annular edema At B the hook has been insinuated past the cap C the cap withdrawn above the edematous area to a widening of the bronchus where a lateral branch is given off In this location it was easy to apply the forceps securely for the withdrawal (D) In using hooks it is necessary to be exceedingly careful to avoid pulling when the hook slips around to the wrong side (E) Pulling then might cause fatal trauma No hook of more than a half turn (90 degrees) should be used because of the risk of getting caught in a branch-bronchial orifice Usually they are better made spirally

of long practice Manipulations to be safe must be guided by the eye, and it must be a trained eye Coordinate manipulations of the tube and forceps must be practiced until work is as natural and familiar as with knife and fork It is as impossible as it would be brutal to attempt to acquire this coordinate skill by practice on the living human being Appalling mortality and failure to acquire the skill would result Fortunately the simple rubber-tube manikin³ serves the purpose perfectly, as it is always available for practice in spare moments Next should come practice on the cadaver and on the living dog with foreign bodies of various kinds placed in the bronchi One is never through practicing for the general education of the eye and fingers In addition to general practice with miscellaneous objects, when a foreign body case comes in, the endoscopist should place a duplicate of the foreign body in a rubber tube of the size of the invaded bronchus and by manipulation with bronchoscope, or œsophagoscope, as the case may be, he can familiarize himself with the appearances of the foreign body in every

possible presentation and he can study and work out a solution for every possible problem. A little ingenuity will closely simulate every difficulty to be encountered in the living patient. For instance, little useful practice will be afforded by removing peanut kernels loosely rattling round in a rubber tube of large diameter. Peanut kernels are not encountered that way in the living human bronchus, they are tightly bedded in the smallest bronchi they can enter. For simulating actual working conditions a half kernel should be pushed down into a rubber tube in which it is a tight fit. Then let the practitioner practice the removal as mentioned under "Peanut Kernels." If anyone will follow this plan he will come close to 100 per cent successful.



FIG 3.—This coin is apparently just ready to be easily picked out with any kind of forcep. As a matter of fact a very good endoscopist after an hour's work under ether failed to grasp the coin for the lack of appreciation of the very simple mechanical principle illustrated in Figs 4 and 5. Similar cases are constantly coming to the Bronchoscopic Clinic. Plate by Dr Willis F Manges

removals and will have little or no mortality. I am sure that the appalling mortality that has attended bronchoscopy and œsophagoscopy in inexperienced hands would never have occurred had the operators realized how little chance there is of the survival of a little child undergoing an œsophagoscopy in inexperienced hands. This is true of simply the introduction of the œsophagoscope. How much more forcibly it should apply to complicated removals. For instance, no one should think of attempting the endoscopic removal of a safety-pin without hundreds of hours of training of the eyes and fingers to the unusual requirements of the work. To ignore this is to trifle with human life. It is infinitely worse than to attempt removal of cataracts from a living human eye without previous practice on dead animals'

eyes, which would result in blindness, not death. The removal of an open safety-pin is infinitely more difficult to learn because the cataract operation is a bimanual and binocular procedure to which all surgical work is more or less a fundamental training, whereas foreign-body endoscopy is a monocular, depth-gauging procedure surrounded by so many limitations and difficulties as to place the operator under "an indescribable stress" as Ingals so aptly stated. For a surgeon to telegraph for a bronchoscope or an œsophagoscope the like of which he never saw before and to start down the tender passages of a child in search of an open safety-pin usually ends in involuntary manslaughter, using the term literally, not in its technical sense. The author assumes part of the responsibility for these not infrequent deaths. From a mistaken sense of modesty he refrained from stating the case strongly so long as few or none had equal opportunities for experience,

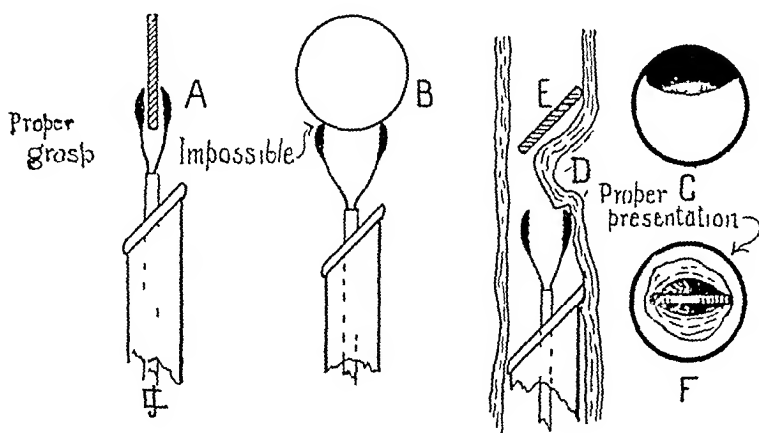


FIG. 4.—The cause of many failures to seize a coin in the œsophagus. The seizure should be flatwise as at A, not edgewise as at B. No attempt should be made to seize the coin in the position at which it is usually first seen C, because one jaw of the forceps will fold, as shown in cross section at D, preventing the proper presentation. The lip of the œsophagoscopic tube-mouth should be used to obtain a proper presentation as shown at F. The same principles govern the grasping of all flat objects in the œsophagus or tracheobronchial tree.

but now that every large medical centre has an experienced endoscopist, there is no more need of totally inexperienced men attempting œsophagoscopy than for every internist to do his own appendectomies.

The study of the presentation is fundamental for safety and success. In foreign-body bronchoscopy, as in accouchement, the ruthless pulling upon any part presenting without consideration of the other parts is to court disaster. Just as the obstetrician studies out the position of the foetus and every part of its anatomy in relation to the maternal pelvis just so must the endoscopist study the position of the foreign body and the relation of its every part to the invaded bronchus or œsophagus. Just as the obstetrician depends upon abdominal palpation to aid him in his interpretation of the presentation, so the endoscopist studies the roentgenogram made in two planes, the lateral and the anteroposterior, so that he may know when he looks at the endoscopically visible part of the foreign body, where the other parts lie. The ray-plates should be on a shadow-box in the operating room, and the

author prefers to have the plates placed upside down for a better conception of the relations in the recumbent patient. When the presentation is not a favorable and safe one for delivery, a version must be done, as, for instance, when the pointed limbs of a double-pointed tack² are turned away and the head brought into the presenting position—a cephalic version⁴.

Forceps Spaces—Fundamental in the endoscopic removal of foreign bodies is the matter of forceps spaces, which is the name I have given to the spaces between the foreign body and the wall of the invaded bronchus or oesophagus and into which the jaws of the forceps must go before they can grasp the foreign body. Of all the causes of failure to remove a foreign body whose location has been reached, in the cases coming to the Bronchoscopic Clinic, none is so frequently the evident cause of failure as lack of

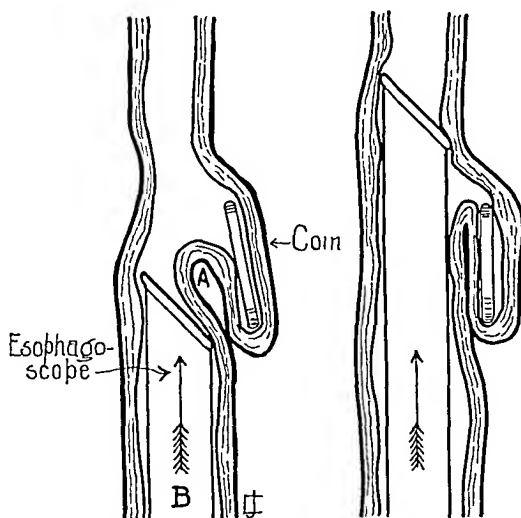


FIG 5—How a foreign body is so frequently overridden unseen by the inexperienced oesophagoscopist. The oesophagoscope advancing in the direction of the dart through the normally collapsed oesophagus pushes ahead of the tube mouth a fold A that obscures the view of the coin which becomes buried in the folds alongside the advancing oesophagoscope. This is most likely to occur at the cricopharyngeus but may occur at a number of other locations.

knowledge or appreciation of the fundamental importance of forceps spaces. Over and over again the mucosa in the neighborhood of a foreign body has evidently been traumatized in an effort to force the jaws over the foreign body when no spaces for the entrance of the jaws existed, or futilely jamming the forceps into the mucosa in an effort to force the forceps onto a foreign body with the jaws opening sagittally ignoring the lateral forceps spaces that would have facilitated grasping had the forceps been turned so the jaws would open in the coronal plane. Had the bronchoscopist been working with both eyes and both hands in an open wound, he would make no such mistake but being unfamiliar with the work and never having been taught the necessity of study of the forceps spaces, when he at last finds a foreign body for which he has been searching he thinks of nothing in his haste to use the

BRONCHOSCOPIC EXTRACTION OF FOREIGN BODIES

forceps Many blind graspings and jabbings in the neighborhood of the foreign body not only fail to grasp it, but by the blood drawn from the mucosal vessels the intruder is so obscured that recognition afterward becomes impossible, and the foreign body is "lost" Had the bronchoscopist recognized his forceps spaces, or created one or two as the case required, the forceps could have been accurately placed under the guidance of the eye and removal accomplished in a few seconds or minutes at the first attempt Forceps spaces are usually at their maximum on inspiration They decrease immediately, not gradually, at the beginning of the expiratory phase of the respiratory cycle

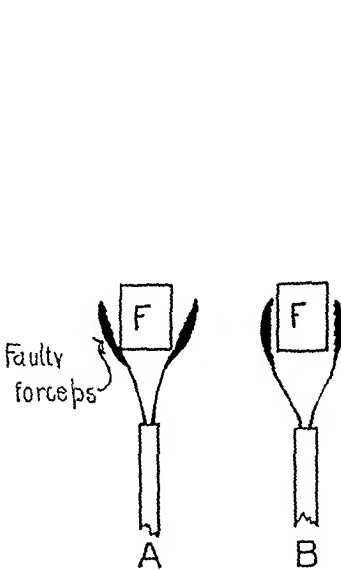


FIG 6—Good and bad construction of forceps The faultily constructed forceps (A) with planes of grasping surfaces divergent not only afford an insecure grasp but by reason of the small area of contact really only pivotal, permit the foreign body (F) to swing sidewise at every touch of the natural passages which swinging is sure to result in loosening the foreign body from the grasp of the forceps Proper forceps (B) have the planes of the grasping surfaces parallel

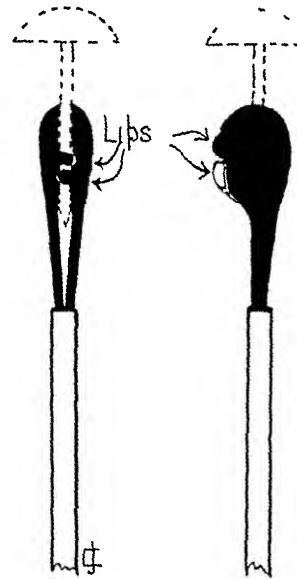


FIG 7—Side and top views of the Tucker forceps The small lips added to one side of the side curved forceps by Dr Gabriel Tucker prevent the slipping out of the shaft of a foreign body, such as a tack or a pin or a safety-pin during the turning out of the point from the mucosa and the bringing of the point into the tube mouth This forceps adds to the Jackson method of safety-pin removal a certainty which makes this method an ideal one The Tucker forceps are also excellent for the disimpaction and removal of tacks pins and nails

In some cases both spaces exist only on inspiration, and the bronchoscopist must wait and watch, with forceps jaws close to the foreign body, for his opportunity, early in the inspiratory phase of the respiratory cycle, promptly, though gently, to insert the forceps jaws into the forceps spaces as they gape The prompt collapse of the bronchial walls at the beginning of inspiration renders it necessary to start the insertion of the forceps jaws at the beginning of the inspiratory phase If later, the jaws will be met and stopped by the collapsing walls Where one space only exists, and that on inspiration, one of the hereinbefore mentioned means must be used to get the

foreign body into a new position in which two forceps spaces will appear either continuously or on inspiration. This respiratory opening and closing

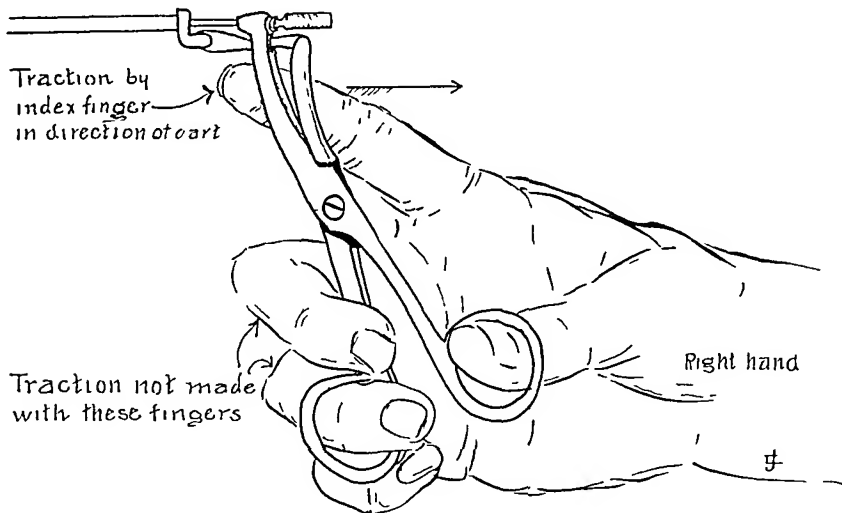


FIG. 8—Proper manner of holding forceps. The ring finger in the ring, the index for pulsion and traction

of the forceps spaces is most frequently seen in cases of peanut kernels in the bronchi, in which class of cases the forceps spaces admit air (See colored

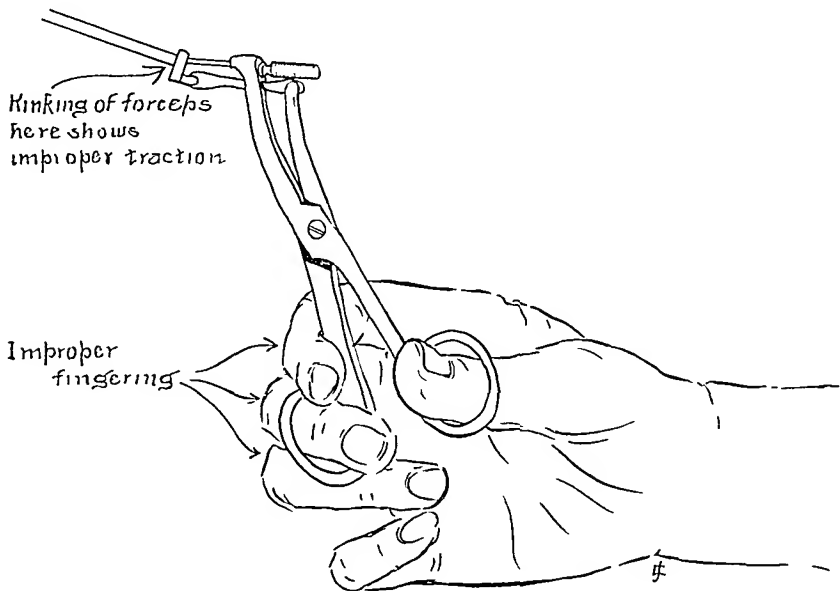


FIG. 9—Improper use of forceps. Forceps can be so constructed as to do away with the springing upward here shown but the delicacy of touch essential to safe and efficient work would be thus destroyed

plate) Where forceps spaces do not exist they may be created by four different means, used singly or in combination of one or more, involving more or less change in the presentation

BRONCHOSCOPIC EXTRACTION OF FOREIGN BODIES

- 1 Displacement of one wall with the lip of the bronchoscope or œsophagoscope
- 2 Tilting of the foreign body with the lip of the bronchoscope
- 3 Tilting of the foreign body by means of the side-curved forceps insinuated at one side and used as a hook
- 4 Withdrawal of the foreign body by means of hooks of certain permissible forms, to a new position in which less swollen walls or a normally larger lumen creates forceps spaces. If withdrawal to the site of a branch bronchial orifice can be accomplished, large forceps spaces are afforded (Fig 2)

Of all causes of failure of our predecessors to remove a coin in the œsophagus in the cases coming to the Bronchoscopic Clinic, next to failure

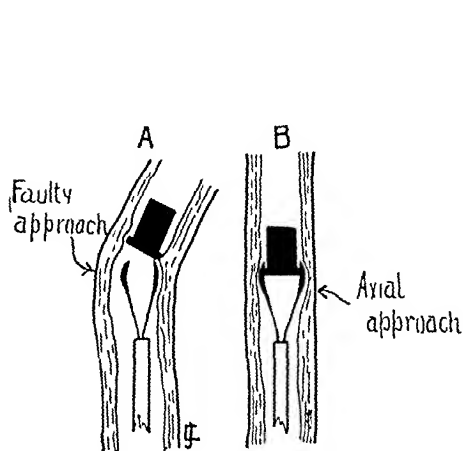


FIG 10 —If the axis of approach is at an angle (A) instead of vertical to the presenting plane (B) of the foreign body the intruder will be pushed down without either blade having had any chance to pass outside of the presenting part of the foreign body. The faulty angle of the approach (A) will often be encountered unless the head of the patient is moved in the proper direction to obtain an axial presentation of the bronchial lumen and an axial approach (B) to the foreign body

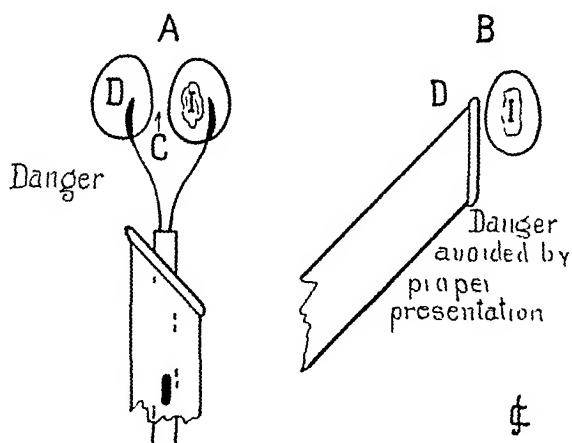


FIG 11 —How to avoid including the dividing spur in the grasp of the forceps. If in an attempt to grasp the foreign body, the forceps are allowed to expand with the bronchoscope exposing both bronchial orifices as at A, the spur is apt to be caught, giving an insecure hold, and dangerous trauma is almost certain to be inflicted. (See illustration D in the colored plate). By moving the head to the left the foreign body is presented centrally and the spur, C, is out of the way to the left the bronchial orifice, D, passing out of the endoscopic field of vision and out of harm's way

to find the coin because of overriding, the most frequent cause has been failure to establish two forceps spaces that would permit of proper approach and proper grasping, as shown in Fig 10. It seems strange that a man who would naturally pick up a flat object flatwise if he were working at a bench with nippers, will try to put on the forceps edgewise in his haste to grasp a coin for which he has been, perhaps, searching a long time, yet the forceps marks on the mucosa and the statement of the unsuccessful œsophagoscopist showed clearly in dozens of these cases the faults mentioned.

Forceps—Endoscopic foreign-body work differs from general surgery in that instruments must be properly constructed to obtain a high percentage of successes and a low mortality. The abdominal surgeon may use a kitchen spoon as a makeshift retractor without loss of time or efficiency, but the limitations inseparable from the necessity of working through a long endoscopic tube of small diameter are such that the slightest departure from the required design may make all the difference between success and failure,

indeed between life and death. For instance, the slight departure from the shape of the jaws of the forceps shown in Fig 6 made the forceps worthless. The endoscopist who failed to hold his foreign body did not realize that though they had been foisted upon him as of my design they were faulty copies of the forceps that have stood my every test for twenty years. When properly made they convey an exquisitely delicate sense of touch. For general purposes the side-curved forceps advocated by me in the early days of bronchoscopy still remain the standby for the majority of the cases, with the plain forceps and the rotation forceps next in usefulness. On rare occasions

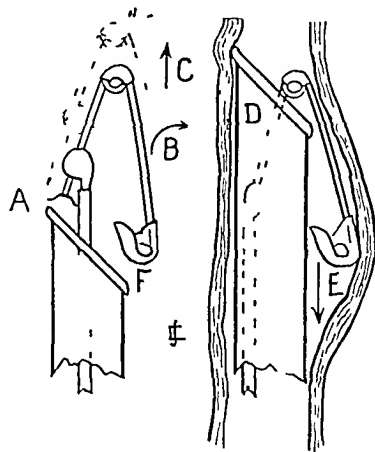


FIG 12—Author's method of dealing with the problem of the safety pin lodged open and point upward. The point of the pin is always sunken into the mucosa as shown at A. The pointed branch of the pin is seized with the forceps which are then rotated about 90 degrees so as to get under and turn out the point as the pin is pushed downward with the forceps. This double movement is indicated by the darts B and C. The tube is then pushed downward over the pointed branch of the pin until this branch is completely within the tube (D). The pin is then withdrawn the keeper sliding harmlessly up outside the tube (E). The keeper really lies closer than shown in the drawing which is made schematically to emphasize the fact that the keeper is outside. Care to maintain the greater plane of the keeper coronally is necessary at the cricoid in the case of the œsophagus or sagittally at the glottis in case of the tracheobronchial tree.

it has been found advantageous to lock the forceps closed on a foreign body while at work upon it. For this a clamp is applied to the handle.

A number of special forceps for special purposes have been devised. Of my own devices there is no need of mention here. Spencer's forceps hold screws well.

My assistant, Doctor Tucker, has added a lip to the side-curved forceps which overcomes one of the greatest difficulties in turning out the point of pins, safety-pins, needles, tacks and similar objects when the point is buried in the mucosa. The lip is too short to inflict serious trauma from light grasping. Of course, if traction is made upon tissues serious or fatal trauma may be inflicted with any kind of forceps. Care and gentleness are necessary in the use of any kind of bronchoscopic or œsophagoscopic instruments.

As mentioned under 'Use of Forceps,' heavy construction destroys all delicacy of touch. Great strength is not necessary, but the temper of the steel must be such that it will bend before it will break. Occasionally it may

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be desired in the solution of some mechanical problem to clamp the forceps onto a foreign body in a certain chosen position. For this purpose the clamp shown is used. It is so rarely required that it is made detachable and applicable to any of the forceps handles.

The use of forceps requires study and, especially, practice, so that their handling and coordination with the tubal manipulations becomes as natural



FIG 13—This illustration shows the advantage of turning the röntgenogram upside down for œsophagoscopy and bronchoscopy in the recumbent position. This contributes to a proper conception at bronchoscopy of where the unseen parts of a foreign body are in relation to the visible parts. The irregular double hook shaped piece of metal was in the œsophagus of a girl aged three years (Case No Fbdy 785). Both hook-shaped ends were buried in the œsophageal wall requiring special manipulations for the solution of disentanglement and safe removal. By comparing the schema Fig 14 it is seen that by placing the röntgenogram upside down all the relations correspond to those encountered at endoscopy.

and automatic as the use of knife and fork. The forceps are, mechanically speaking, a prolongation of the fingers. Their necessarily great length makes their use somewhat in the nature of walking on stilts. Special practice is necessary to acquire perfect control. This practice should be first on the rubber tube manikin and this practice should never be abandoned. It is what scales and exercises are to the musician.

The forceps should be held as in Fig 8 This placing of the fingers can be memorized by the formula "The ring finger in the ring" This position leaves the index finger free for pushing (always gently) on the stylet When traction is necessary it is also made with the index finger in a mechanically correct manner, as shown in Fig 9 It is for this use of the index finger that this forceps was designed It gives a delicacy of touch transmitted through the most sensitive tactile member with which man is

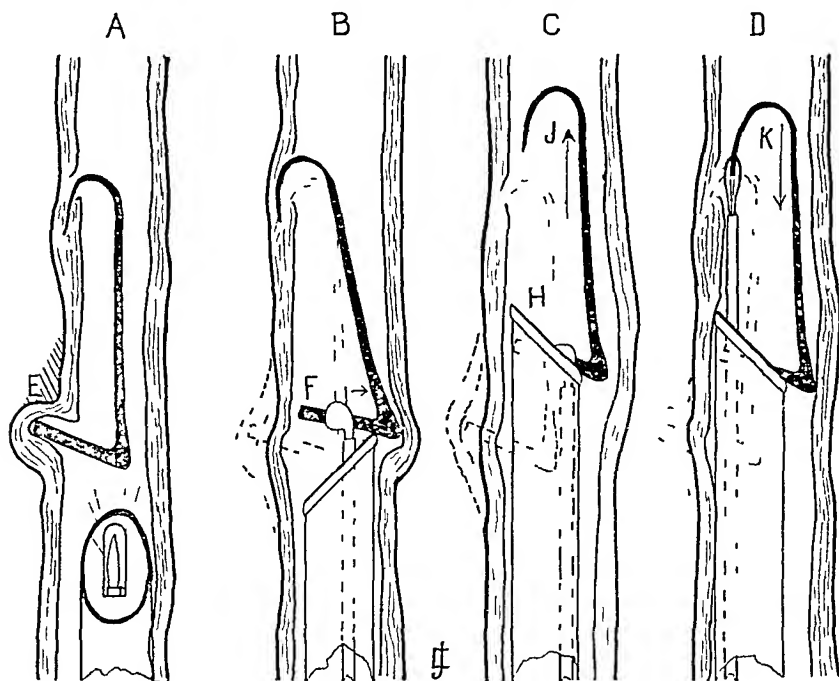


FIG 14—Schematic illustration of the problem of the double opposed hooks presented in the case illustrated in Fig 13 The distal hook had penetrated the mucosa while the proximal hook E was buried and locked in a fold above the cricopharyngeus (E) over which it was hooked The removal was accomplished in six stages

- 1—Manipulation of the proximal hook strongly in the direction of the dart F
- 2—Guiding the proximal hook down through the cricopharyngeal narrowing E so as to disengage the distal hook J
- 3—Pushing the oesophagoscope downward so as to repress the cricopharyngeal fold E
- 4—Placing the lip of the tube mouth under the proximal hook H to prevent its catching during withdrawal
- 5—Seizing the point of the distal hook K with forceps to prevent the point catching during withdrawal
- 6—Withdrawal of the foreign body the forceps and oesophagoscope together as one piece

Time required 9 minutes and 37 seconds No anæsthesia was used and there was no trauma and no reaction (Case No Fbdy 785)

endowed Forceps designed to do away with the springing upward, shown in Fig 9, are like making a violin bow of cast iron so it will not yield The parts of a forceps outside the tube can be made as heavy as desired and opening springs may be added, but when these things are done all delicacy of touch is destroyed

The axis of approach of forceps is of the utmost importance, and especially so in case of foreign bodies with a more or less flat face occluding most of the area of cross-section of the bronchus As will be understood from Fig 10, a wrong angle of approach may make all the difference between the removal in a few minutes on the one hand, and on the other, not only

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failure to seize the foreign body but pushing it down tightly into a position in the bronchus from which removal may be exceedingly difficult. Before insertion of the forceps the axis of the bronchoscope should always be brought into the position in which its axis corresponds to that of the invaded bronchus. If in doing this one edge of the field of view is obscured by the projection of the angle of the bronchial wall, the obtruding angle may be repressed with the lip of the bronchoscope. Usually all that is required is the rotation of the bronchoscope so as to bring the lip around to the obtruding sector. In the œsophagus axis of approach may increase those difficulties of proper grasp due to faulty presentation and lack of forceps spaces, as illustrated in Fig 4.

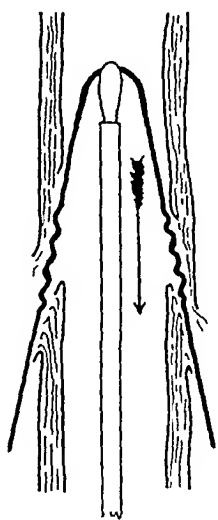


FIG 15 — Schema showing how fatal trauma can be and has been inflicted by injudicious traction, in the direction of the dart on a hair-pin lodged points upward in the œsophagus

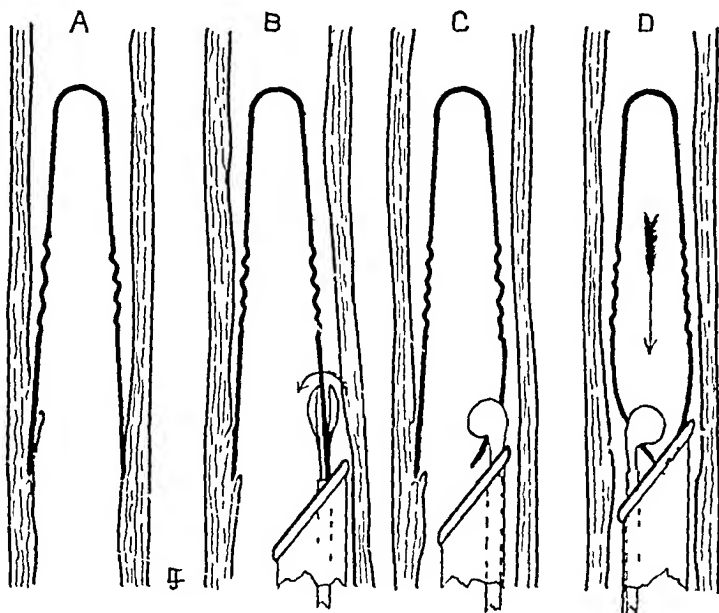


FIG 16 — Schema showing how the danger shown in Fig 15 was avoided by a carefully worked out solution of the mechanical problems involved. The points of an object like this have either penetrated the mucosa or penetration is imminent. First one point is turned with side-curved forceps (B C), then the œsophagoscope (or bronchoscope) is pushed down so that the turned point rests on the lips of the tube-mouth while the other point is turned in. Thus protected, traction in the direction of the dart is safe. (Case No Fbdy 837)

Avoidance of inclusion of tissue in the grasp of the forceps is very important for three reasons. (1) Serious or fatal trauma may be inflicted by the laceration of blood-vessels. (2) Laceration of the bronchial wall may allow air and infective material to leak into the pleural cavity, producing a serious complication, or into the mediastinum, causing death. (3) Tissue between the forceps and the foreign body renders the grasp insecure. For these three reasons pulling upon a foreign body when tissue is included with the foreign body in the grasp of the forceps usually ends not only in failure to remove the intruder, but also in serious or fatal illness of the patient. See Fig 11 also D in the color plate.

Safety-pins—An open safety-pin, lodged point upward in the hypopharynx, is readily rotated with alligator forceps so that the point is in the

spatular tip of the laryngoscope which thus protects the tissues from laceration. The same method is ideal also in cases of laryngeally lodged safety-pins. In cases of deeper lodgment in either the œsophagus or tracheobronchial tree the pin may be similarly removed by flipping the point onto the lip of the tube-mouth or the pin may be closed or removed by the author's point-protected method² by which the pointed branch of the pin is brought as far as it will come into the tube-mouth. The pin, forceps and tube are then all brought out together, the keeper branch sliding upward harmlessly on the outside of the tube. Fig 12 illustrates the method more clearly than the original illustration. This method will be greatly facilitated by the lips added to the side-curved forceps (Fig 7). The chief difficulty encountered in the plan of

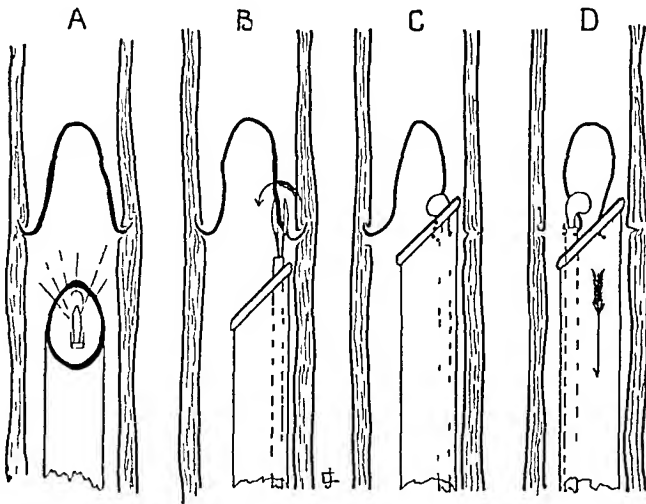


FIG 17—Schematic illustration of the method of disentangling a sharp pointed double hook shaped wire from an egg beater that had lodged in the œsophagus of a woman aged 57 years while eating custard pie (Case No Pbdy 434). The two hook shaped sharp ends were buried in the mucosa (A). At B and C are shown the author's cutward rotation method of disembedding buried points of any kind in this case the wire being annealed the points were easily bent one at a time inward toward each other to get them into the tube-mouth for safe traction (D). The solution of the problem would be the same if the foreign body had lodged with the hooked ends downward. The method used in this early case has since been used many times in the Bronchoscopic Clinic for the removal of hair-pins bent wire etc.

getting the pointed branch into the tube-mouth was the tendency of the spring of the safety-pin to throw the pointed branch out of the grasp of the forceps. This the lips of Tucker's forceps prevent. These forceps make of my point-protected method the least difficult of all the plans of dealing with the open safety-pin. Closure and endogastric version are two excellent methods elsewhere described. Success and a reasonable degree of safety with any method of extraction of safety-pins lodged point-upward requires long preliminary practice on the rubber tube.

Rules for Rontgenographic Examination of Safety-pin Cases—In dealing endoscopically with an open safety-pin, lodged point upward, the six most essential things to know beforehand are

- 1 The size of the pin

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- 1 The size of the pin
- 2 The greatest spread from the point to the keeper
- 3 The exact plane of this greatest spread
- 4 The direction of the point
- 5 The precise location of the point, the keeper and the spring
- 6 The degree to which each of the two branches of the pin deviates from the vertical axis of the patient's thorax



FIG 18 —Röntgenograms anteroposterior and lateral, showing staple in the subglottic trachea of a girl aged 4 years (Case No Fbdy 825) Removed laryngoscopically through the mouth by cephalic version in one minute and thirty-five seconds without anaesthesia, general or local The illustration also shows the necessity of the ray study in two planes The lateral view conveys no idea of the complicating curves and divergent points that it was necessary to know in order to accomplish the version Plates made by Dr Willis F Manges

7 Bends, breaks, kinks or other imperfections of the pin

More failures safely to remove safety-pins have resulted from lack of a properly preconceived mental conception of all of these data as to the particular case than from any other one cause All of these data can be supplied

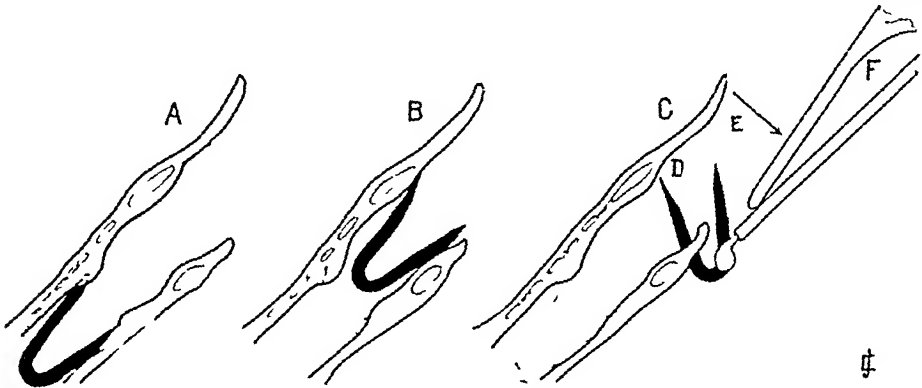


FIG 19 —Illustrating the solution of the problem of the staple with buried points in the case illustrated in Fig 18 by posterior version (C) The turning was done after working the staple upward one point at a time (B) always guarding the advancing point The trailing point (D) has no tendency to puncture The laryngoscope (F) is exerting pressure (E) on the forceps in a posterior direction to complete the version

by the röntgenologist To get these data one plate at least should be free from foreshortening With these data and a duplicate of the pin the trained bronchoscopist can in a few hours with his bronchoscope or œsophagoscope and a bit of rubber tubing work out the problem in such a way as to make him feel sure of safety and success in dealing later with the patient The

working plates in the operating room should include a lateral, an antero-posterior and one free from foreshortening

Irregular Metallic Objects—The varieties of these are numerous, but the general principles of the solution of the problems of extraction are the same. A careful ray-study in all planes is made to ascertain the dimensions of the foreign body and the planes in which the greatest and least dimensions lie. Then a study is made to determine the position of points, rough places, hooks, angles or any other potentially traumatizing characters of the foreign body. A plan is next worked out, first in theory, then on the rubber-tube

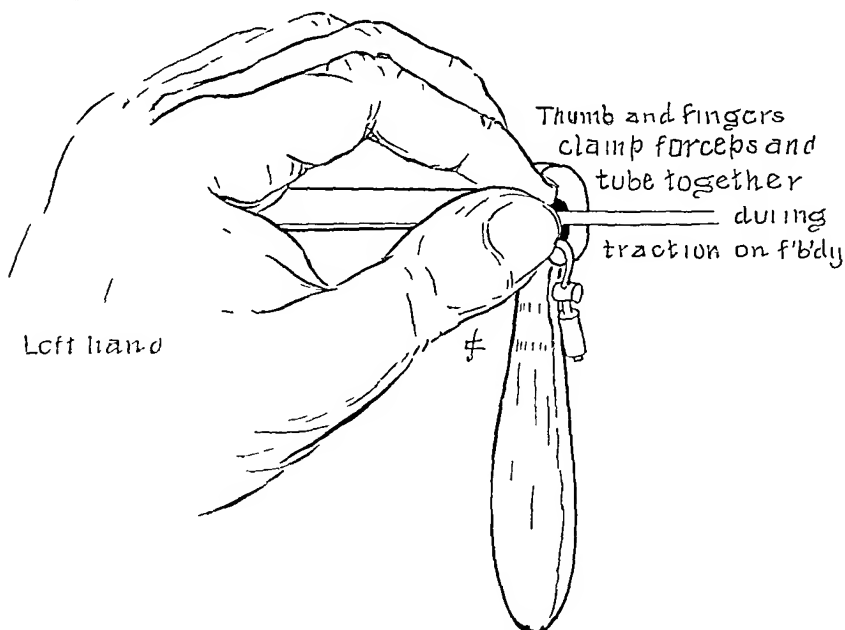


FIG. 20.—In order to avoid the lagging behind of the foreign body (see Fig. 21) and to insure the movement together of the foreign body, the forceps and the bronchoscope all as one piece, the left hand should be used as here shown to clamp the cannula of the forceps against the proximal tube mouth while traction is being made. The left hand should make all the traction; the right hand simply moving along passively while making the necessary degree of compression on the forceps handles. This method applies to the removal of any and all foreign bodies that are too large to be withdrawn through the tube.

manikin, by which hooks are disengaged, points guarded, rough places turned or held away during withdrawal so as to avoid trauma. A good illustration of the method of working out these various problems, or combinations of problems, is shown in Figs. 13 and 14, and will be understood from reading the legends.

Hair-pins and Bent Wires—These cases are similar to the staple in that the points become buried (Fig. 15 and Fig. 17), but they differ in that the wire is of smaller gauge and is annealed, hence is easily bent. The fence staples are of rigid wire that cannot be bent or cut by any instrument that can be used through a bronchoscope.

The wire from an egg-beater was quickly and safely removed by the method shown in Fig. 17.

The hair-pins were removed by the method illustrated in Fig. 16. Being

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of stiffer wire a forceps of different shape facilitated the bending of the points

Fence Staples—The surpassing difficulty in dealing endoscopically with these objects when encountered points upward, as they usually are, arises from their construction. In order to be driven into wood the points are made very sharp and the steel is very rigid. The points are spread and they rip in upon the slightest effort at traction. The wire cannot be cut or bent with any instrument slender enough to go through a bronchoscope. The method of cephalic version by which the author first solved the exceedingly difficult problem, presented by these foreign bodies when they are lodged point upward,⁴ has proven entirely satisfactory in seven subsequent cases,

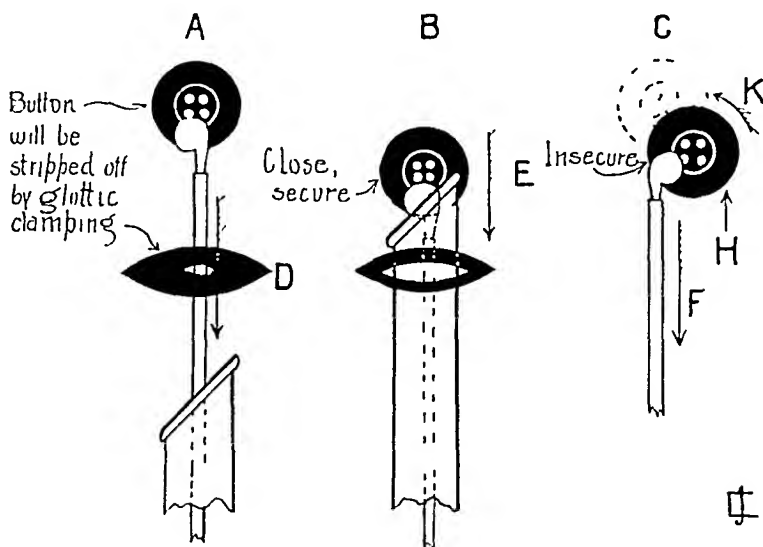


FIG. 21.—Illustrating the necessity of keeping the foreign body close to the tube-mouth during withdrawal so as to emerge with the tube (B). If allowed to trail as shown at A it will be stripped off the forceps by the glottis (D) clamping tightly around the stem of the forceps. This applies to the endoscopic removal of all foreign bodies too large to be brought out through the tube. In oesophageal work the cricopharyngeus will strip off the foreign body in the same way as the glottis does at bronchoscopy. Therefore D in the schema above may be taken to mean either glottic or cricopharyngeal clamping. At C is shown the fault of the one-sided grasp of any foreign body in endoscopic removal. When traction is made in the direction of the dart F the resistance of any tissue encountered (H) by the sideways projecting portion of the button will cause the button to be rotated in the direction K inevitably loosening it from the grasp of the forceps. (See also Fig. 33.)

in all of which the staple was removed without mortality. The essential thing to remember in turning or otherwise manipulating these objects is that the trailing point does no harm, whereas the advancing point will rip in unless it is watched and the tissues are safely guarded. In a recent case (Fbdv No. 825) of a staple in the trachea of a girl, aged four years, the points were found buried in the swollen subglottic tissues below the anterior and posterior commissures, respectively, the greater plane of the staple being sagittally lodged (Fig. 19). The posterior point was readily seized and advanced up out of the larynx, the anterior point being caused to trail downward as the curved head was brought upward. The head was then gently forced posteriorly against the soft-tissue wall which yielded enough to permit version. For success with staples it is essential to have beforehand

a mental conception of the staple in all its relations For these the ray-study should be made to determine

- 1 The exact length of the staple free from foreshortening
- 2 The extent of the spread of the staple from point to point
- 3 The plane of the greatest spread
- 4 The location of the staple
- 5 The degree of divergence of each of the two branches of the staple from the parallel
- 6 The form, size and axis of the bronchi in the neighborhood, as shown in stereoscopic plates If necessary, the author's method of lung-mapping by the insufflation of bismuth may be used to increase the visibility of the bronchi

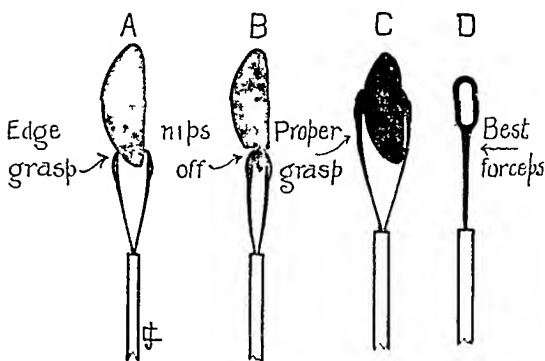


FIG 22—Illustrating the right and wrong ways of grasping peanut kernels and all other friable substances If the forceps are applied close to the presenting edge (A) a fragment of the edge will be nipped off (B) With proper forceps and a gentle hand the peanut kernel will not be crushed if grasped over the minor axis as shown at C The author's special peanut forceps (D) have proven very satisfactory The long soft spring of the jaws as well as the fenestra and the springless handle all contribute to gentleness of grasp with sufficient holding power

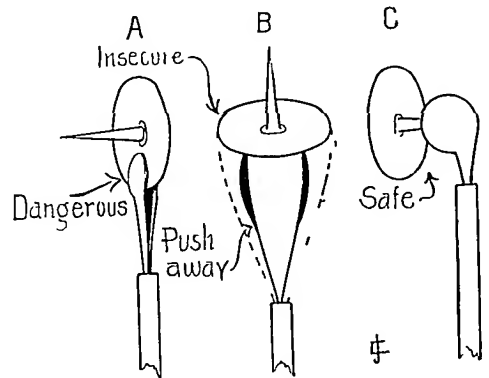


FIG 23—The problem of the thumb tack If grasped as shown at A serious and if in the oesophagus fatal trauma will be inflicted during removal If the flat face of the head presents as at B the attempt to apply the forceps will push the intruder into a lower and more difficult position and even if the forceps were gotten over the periphery of the disk-like head as shown by the dotted lines (B) the hold would be very insecure If the stem of the tack is grasped as at C the hold will be secure and most important the point will be covered so as to protect the tissues from trauma All other presentations should be converted into this one (C) by version with the forceps and the lip of the tube-mouth used coordinately

Peanut kernels and similar friable substances, such as beans and maize, require great delicacy of touch So exacting is this requirement that it is my rule when a series of cases at a clinic included a peanut case, always to take it first in order that delicacy may not be obtunded by any preceding work Peanut kernels are especially friable, the friability varying with the degree of roasting and to a less extent with the degree of maceration To crush a peanut kernel in the bronchus of a child is apt to cause multiple abscesses from the scattered aspiration of minute fragments that cannot afterward be found This is a disaster to avoid which the utmost caution should be taken, while endeavoring to hold the peanut sufficiently securely to prevent its being stripped off at the glottis For these friable substances I have used for years a fenestrated forceps, but have recently added to my equipment for this purpose an extremely delicate model of the plain grasping

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forceps The jaws are very thin, as befits the small forceps spaces usually available in these cases, and a very soft spring permits of the utmost delicacy of touch Great strength is not necessary and these forceps are carefully kept for this particularly delicate work in which they have given the utmost satisfaction Like all other forceps they should have a covering-clamp slipped on over the jaws to keep them closed and protected when not in use, so that the jaws will not get bent backward All forceps should be well oiled in their cannulae before putting away Reliability in instruments depends largely upon their care With the very delicate forceps needed to feel a peanut kernel a well cared for instrument may make all the difference between sending the baby home well in a few days and sending him home in

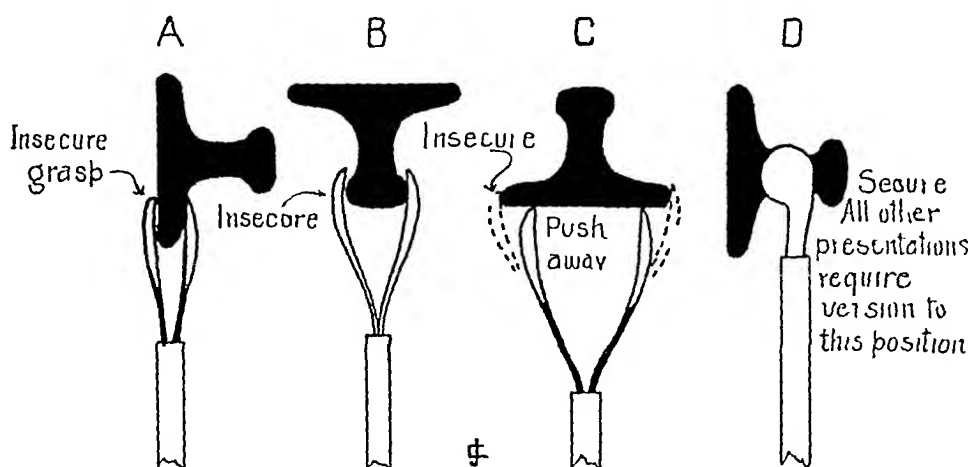


FIG. 24.—The various unfavorable presentations of the collar button and how they are converted into favorable presentations by version. At A is shown a very insecure hold, the collar button is certain to be stripped off at the glottis. At B is shown another insecure hold. In the presentation C it is almost impossible to grasp the collar button and the attempt is likely to push the button into a deeper and more difficult position. Even if the forceps were expanded to the position of the dotted lines the hold would be very insecure because of the tendency to tilt. At D is shown a very secure hold and in this position the collar button meets least resistance in withdrawal. All other presentations should be converted into this one by manipulation with hooks, or preferably side curved forceps and tube-mouth worked coordinately as knife and fork.

a box With a delicate forceps well oiled and working smoothly in his possession the man who expects to be successful in removing peanut kernels without crushing them should crush a few quarts of peanut kernels to acquire the sense of tactile differentiation between the degree of forceps-pressure necessary securely to hold a peanut kernel during its withdrawal through the glottis and the degree of pressure that will crush it This is a purely manual thing to be acquired only by feeling the peanuts crush and then feeling others against the tube-mouth while being withdrawn Knowledge of how to do it is not enough The problem is simulated for practice by inserting half of a peanut kernel in a piece of rubber tubing so small that it fits tightly Then working through the infant size bronchoscope the forceps spaces are found, the forceps placed, and the peanut is withdrawn until it is felt to meet the distal tube-mouth Then the forceps are clamped against the side wall of the proximal tube-mouth with the fingers (Fig 20) so as to fix the tube foreign body and forceps, together as one piece during with-

drawal. This method minimizes the likelihood of having the foreign body stripped off at the glottis as shown in Fig. 21. Much practice is necessary to execute this manoeuvre with soft friable bodies like peanut kernels. If pulled too strongly against the tube-mouth they will be stripped off, or worse, crushed by the tube-mouth forcing the forceps shut. One great fault I find in pupil physicians at the Bronchoscopic Clinic is the nipping off of the peanut kernel by an insufficient grasp. If the forceps close on the equator of the



FIG. 25.—Most buttons occurring as foreign bodies today being made of casein do not show. This one of a denser composition pearl shell shows clearly. The mechanical problems of removal of buttons are illustrated in Figs. 21 and 26.

peanut kernel, crushing is much less likely than if the edge only is grasped (Fig. 22).

Grains of Maize usually present the germ-end the center of which is soft. If this germ is grasped it will come away leaving the "mouse gnawed" grain behind. To prevent this the grain should be grasped as shown at C, Fig. 22.

Tacks, pins, needles and similar pointed objects present problems the solution of which I described years ago.¹ These solutions have stood the test of many cases and have never failed to yield results. One great aid in the execution of these manipulations will be the new Tucker modification of the side-curved forceps (Fig. 7). The little projecting lips prevent the shaft from slipping out of the grasp of the forceps.

Collar Buttons—The many different positions in which a collar button can present itself makes it an ideal object for practice on the rubber tube

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It is a typical example of the value of version in converting an unfavorable presentation into a favorable one for grasping and removal, as illustrated in Fig 24

Thumb tacks present a different problem from other tacks. They also present a good illustration of how a foreign body potentially dangerous may be safely and easily removed. The dangerous and the safe ways are illustrated in Fig 23

Very large foreign bodies in the œsophagus present difficulties that have defeated many œsophagoscopists, some of whom have gone so far as to say that external œsophagotomy with its relatively high mortality is justifiable. This I feel sure is a mistake, apart from the fact that it, in any event, could only apply to foreign bodies high in the œsophagus. Formerly I thought it

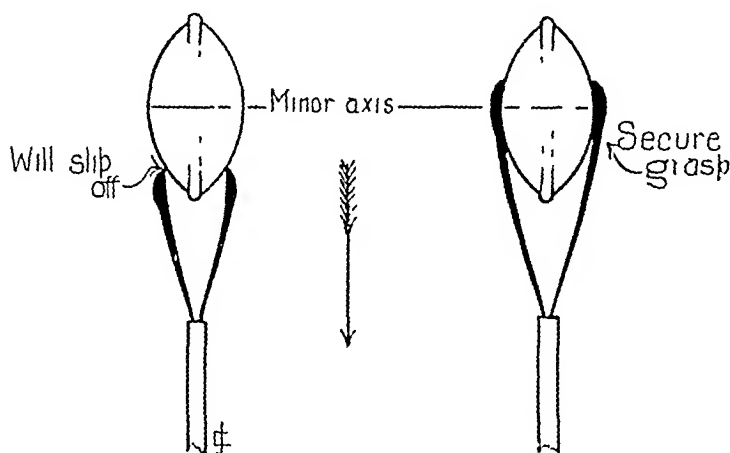


FIG 26—The problem of the thick, hard, smooth surfaced foreign body of conoidal cross-section illustrated in this instance by an ellipsoidal button. If grasped near the vertex the forceps will slip off as soon as traction is made in the direction of the dart. To get a secure grasp the forceps jaws must be placed beyond the minor axis of the ellipsoid or base of the conoid as the case may be. With spheroidal bodies the jaw should go beyond the equator.

necessary in cases of œsophagoscopy for very large and sharp foreign bodies to relax the patient by ether anæsthesia to prevent trauma by the clamping of the foreign body by the œsophageal musculature. This I have found to be rendered quite unnecessary by the hereinafter-mentioned manipulations. Because of the development of this technique also, I have never yet had to resort to morcellation and fragmentary removal of any foreign body because of its size, though preparations for doing so have always been made. If anyone should desire to cut a foreign body it might be well to use the bouginage œsophagoscope because the increased lumen obtained by putting both the drainage and the light canals outside of the wall of the tube permits the use of large, heavy shears. Such a procedure as morcellation introduces special dangers to the patient. I have always, so far, found that any foreign body that has gone down the œsophagus could be brought back the same way, provided certain requirements are fulfilled. To have seized the large intruder with powerful forceps and dragged it out by main strength would undoubtedly have been fatal in many cases. Three precautions are necessary for safety

and success in the author's method of œsophagoscopic removal of very large foreign bodies by rotation and tubal manipulations

1 Very careful preliminary ray-study is necessary to determine the location of any sharp corners or edges, any concavities, hooks, or other possible characters that might impede removal or cause trauma, so that such potentially traumatic factors can be eliminated by version or otherwise

2 The largest possible œsophagoscope must be used so as to hold the œsophageal walls well spread apart during withdrawal The œsophagoscope



FIG 27—Toy jack in the œsophagus Removal presented the problem the solution of which is illustrated in Fig 28

must have the regular slanted end, so as to afford the advantage of the lip in the tubal manipulation of the folds

3 The foreign body must be brought up in the position of least resistance, doing a partial or complete version if necessary for the purpose Rotation forceps are usually the most serviceable instruments for this purpose

4 The foreign body must be kept close up to the tube-mouth during withdrawal for three purposes (a) To keep the foreign body in the space of widely separated walls in the wake of the tube-mouth, (b) to keep the foreign body in view all the way up so as to enable the œsophagoscopist to carry out tubal manipulation of the collapsing folds, (c) to minimize the clamping of the intruder by the collapsing folds

5 A close watch for collapsing walls and clamping folds must be maintained and these must be controlled by manipulation with the lip of the slanted tube-mouth

These methods have enabled me to remove œsophageally lodged foreign bodies in 238 consecutive cases without resort to external œsophagotomy in any case

Hard, Smooth Conoidal Bodies are best dealt with as shown in Figs 25 and 26

Toy Jacks are managed as shown in Figs 27 and 28

The Upper-lobe Bronchi are rarely invaded, but in their proximal portions a foreign body is readily dealt with. When their ascending branches are invaded the difficulties of work are very great as shown in Figs 29, 30 and

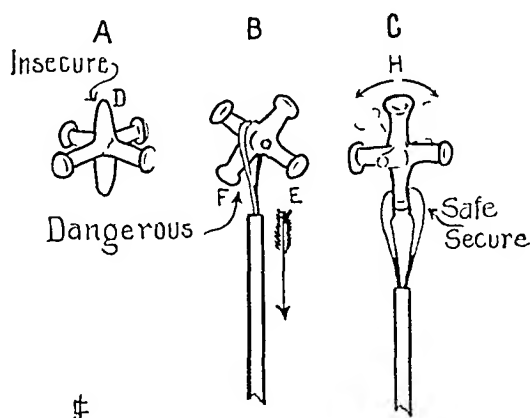


FIG 28—The problem of the toy jack in the œsophagus. The plain points D afford a very insecure grasp. The grasp with rotation forceps B, is very secure but in this grasp the points E and F have a hook-like action similar to a graefe basket and are sure to injure the œsophageal wall by catching in a fold. The most secure grasp and the one that should always be obtained by version if necessary, is with a cupped forceps applied to one of the ball-points. This grasp permits wobbling (H) which permits the other points of the jack to free themselves from the fold encountered during withdrawal in direction of dart. In some cases assistance by rotation with the forceps and tube mouth is needed to free the points.

31, but they have been to a certain extent overcome by methods being developed in collaboration with Dr Willis F Manges

Magnetic Extraction of Foreign Bodies—One of the most frequently asked questions is in regard to the usefulness of magnets in cases of foreign bodies in the lungs. There have been no developments since our report.^{*} The limitations arise from the small size of the foreign bodies and the fact that they are not free to move. The smaller the foreign body the less the magnetic attraction. If an iron or steel foreign body were the size of a sledge hammer it could be pulled out through the chest wall. The only case in which a magnet could possibly be desirable would be that of a tiny iron or steel foreign body in a branch bronchus so small that a bronchoscope could not enter, and these are precisely the cases in which magnets are useless. Inasmuch as we have now developed methods of removing all of these, as all other kinds of foreign bodies with forceps or other instruments it would seem that magnetic extraction is not needed. Moreover, in using a

* Jackson, Chevalier. The Laryngoscope, April 1905

magnet there is no control over the position of the foreign body in relation to the bronchi invaded or to be traversed in extraction. Hence all the niceties of disentanglement and version are impossible. However, all experiment, if not carried out on living human subjects, should be encouraged. The author hastens to add that these are only his personal views.

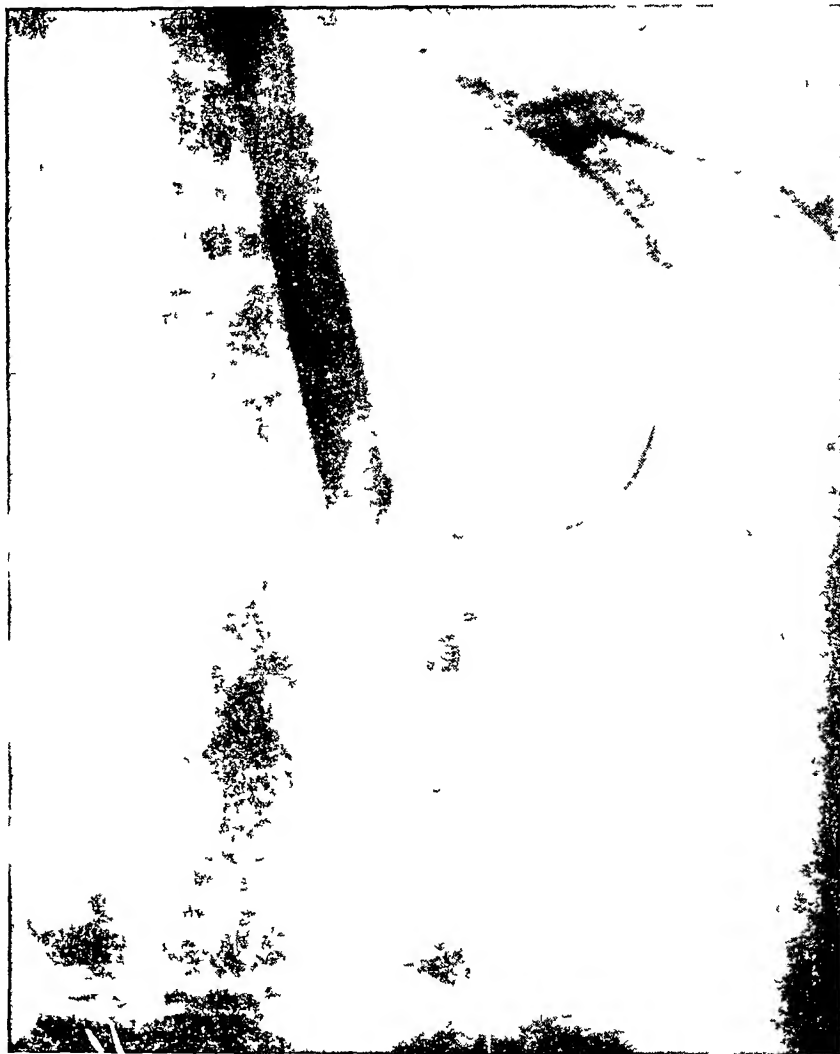


FIG. 1. Showing a coil spring hook reaching around-the corner into upper lobe bronchus of a patient. The hook went beyond the articular coil-spring was of too long a radius of curvature. This plate was made by Dr. Willis F. Manges, whose aid in the development of upper lobe-bronchial work is gratefully acknowledged by the author.

CONCLUSIONS

In all cases of bronchoscopic and œsophagoscopic foreign body extraction the fundamental rule should be the avoidance of risk of mortality. Most of the operations in surgery are bimanual binocular procedures, whereas foreign-body endoscopy is a monocular, depth-gauging procedure handi-

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capped by limitations due to the smallness of the bronchi and the length and slenderness of the instruments. Differing thus from all previous training of the operator, safety and success require eyes and fingers that have been trained to the work. It is impossible, to say nothing of the inhumanity of the attempt, to get this training by work on patients. The time is insufficient. Hundreds of hours should be spent in educating the eye and the fingers with the bronchoscope working with all kinds of foreign bodies in a rubber tube, a cadaver and a living dog. Then when a case comes along a few hours preliminary working in the same way with a duplicate foreign

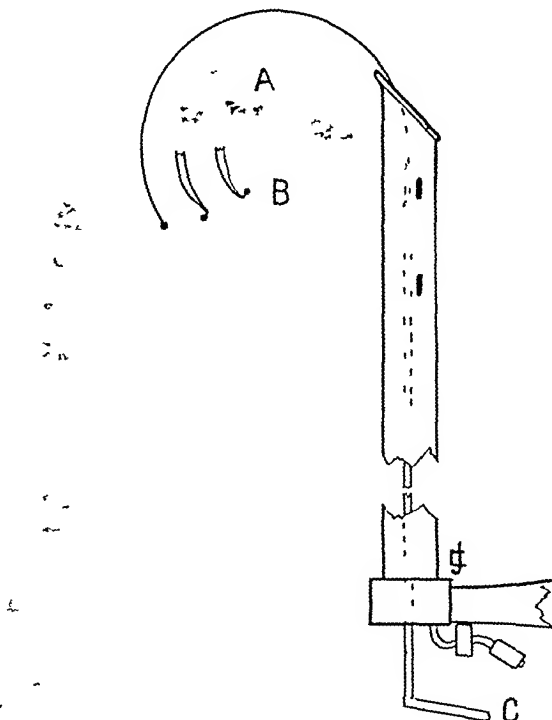


FIG. 30—Coil spring hooks for reaching around-the-corner into the ascending branches of the upper-lobe bronchus. They are straightened in their passage through the bronchoscope resuming their curve after emergence. The degree to which this emergence is permitted regulates the distance of entrance into the upper-lobe and to some extent, the radius of curvature, though hooks of different spring-radius are provided. The hook proper at the extremity (B) does not exceed a right angle in its bent position. Hooks are made in various directions but the two illustrated (B) have the advantage that, if caught, they can be disengaged by manipulation of the handle (C).

body will provide the bronchoscopist with an experience such as he could not obtain from even hundreds of cases. If this plan of preliminary general practice followed by special practice for the particular case be conscientiously carried out, I feel sure that any foreign body that has gone down the natural passages can be brought up the same way provided the following rules for the use of forceps or other extracting instruments are followed.

RULES FOR USE OF FORCEPS

The following rules are those formulated by the author for his own use. Hence they are stated dogmatically. The terms "must" and "should" refer only to what the author says to himself. Each operator can modify them to suit his own personal experience or equation. For convenience the

term bronchoscope is used. Almost all of the rules apply with equal force to the œsophagoscope, the œsophageal speculum and the direct laryngoscope.

1 Before insertion of forceps the long axis of the bronchoscope must be brought to correspond with that of the bronchus invaded by the foreign body.

2 The size and kind of forceps most suitable must be determined before introduction of the forceps.

3 The plane of expansion must be determined before the insertion of forceps.

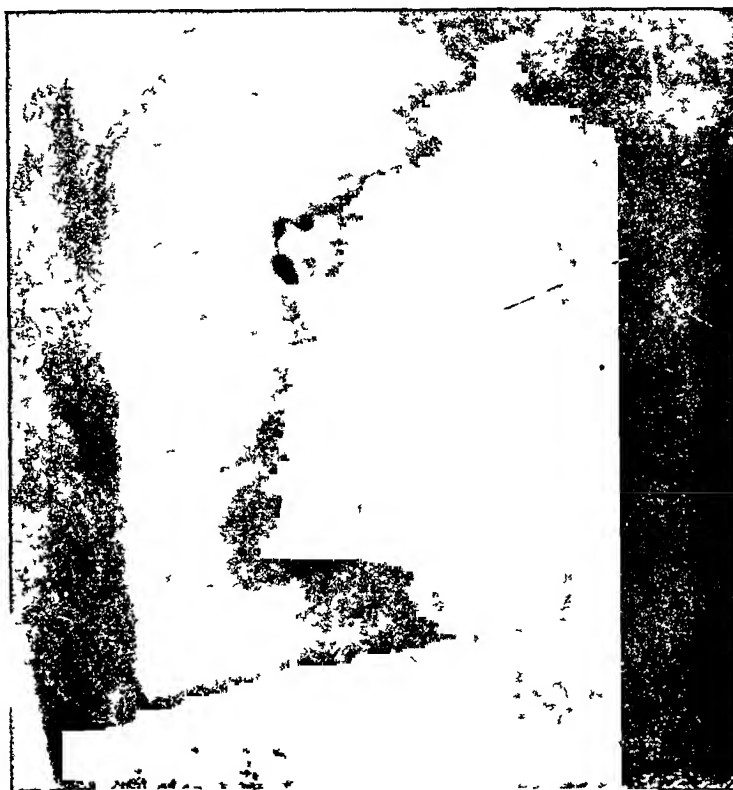


FIG 31—Röntgenogram showing the spiral upper-lobe bronchus forceps extending around 180 degrees in an ascending branch of the upper lobe bronchus. Though apparently in contact with the foreign body the forceps are in a bronchial branch about 2 cm. anterior to the foreign body. Plate made by Dr. Willis F. Manges.

4 The plane of expansion must be determined by the greatest plane of the intruder, the shape of the presenting part and the position of the forceps spaces.

5 There must be two forceps spaces, if two-jawed forceps are to be used, and they must be on opposite sides of the foreign body. If only one exists another must be made by manipulation of either the intruder or the tissues, normal or pathologic, or by working the intruder upward into a wider passage. If none exists two must be created.

6 Before applying forceps an unfavorable presentation must be converted into a favorable one by

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- (a) Creation of forceps space or spaces if only one, or none, exists
- (b) Partial or complete version if required for disentanglement, disimpaction, disengagement of a point, or proper presentation for seizure

7 Great care is necessary to avoid seizing tissue along with the foreign body. In the œsophagus a fold of the collapsing walls, or the cricopharyngeal fold, in the bronchi the spur between bronchial orifices, or even a duplication of the bronchial wall may be included in the grasp of the forceps. To pull, tear or twist with forceps so engaged usually means the death of the patient. If only the mucosa is nipped, fatal injury may not be inflicted, but the prolonged oozing of blood will diminish visibility by obscuring the field and by tinting the surface of the foreign body.



FIG. 32.—Röntgenograms anteroposterior and lateral of a man aged 28 years (Case No. Fbody 887). Showing a very large artificial denture in the œsophagus which before admission could not be pulled out of the œsophagus. Removed through the mouth by œsophagoscopy without anæsthesia in 2 minutes and 11 seconds by the method illustrated in Fig. 33. Plates made by Dr. Willis F. Manges.

8 Traction should never be made until it is certain that the foreign body can be withdrawn without trauma to the tissues.

9 No matter how sure you are that the foreign body is properly seized and free to be withdrawn, never pull strongly enough to tear tissues apart. The safe degree of traction can be determined by the tactile sense trained by experiment on the cadaver.

10 In many instances traction must be preceded by pulsion, or by rotation, or by both, according to the mechanical problem present, in order to free a foreign body or its point.

11 When dealing with a pointed object, no traction should be made until the point is in the tube-mouth or is otherwise protected.

12 The index finger, being keenest in sense of manipulative touch, should be used for traction and propulsion of forceps. To leave it free the middle and ring fingers are inserted in the rings of the forceps.

13 In case of foreign bodies that cannot be withdrawn through the bronchoscope or œsophagoscope, the foreign body must be held closely against the distal tube-mouth by traction on the forceps until the resistance of contact is felt. Then the cannula of the forceps is firmly fixed against the side of the lumen of the proximal tube-mouth as shown in Fig 20. This clamps the

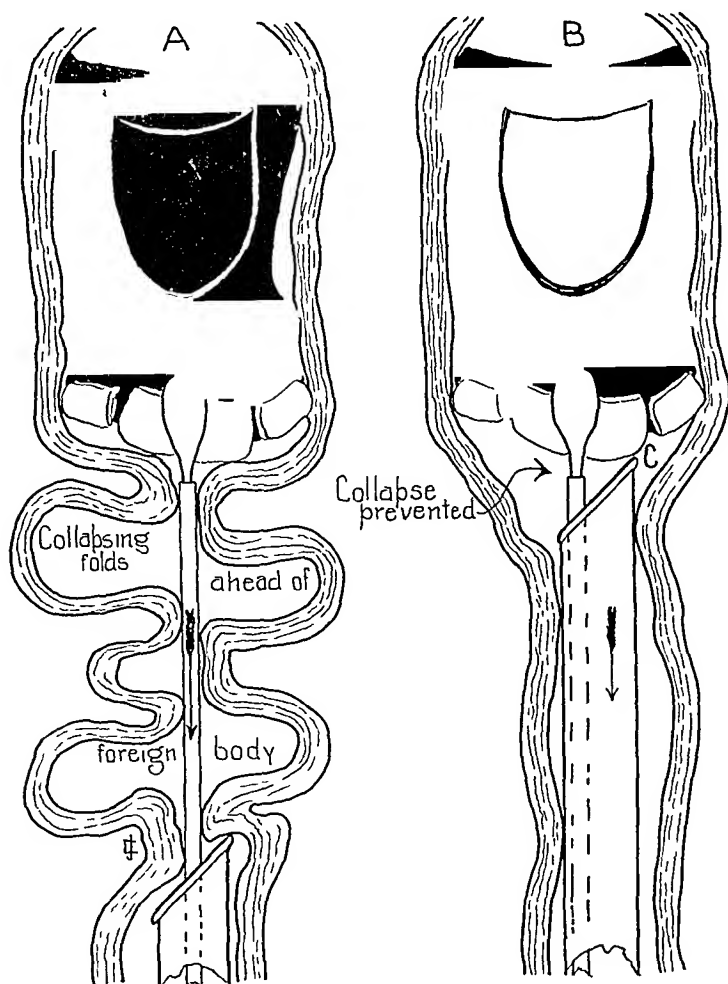


FIG 33—Schematic illustration of the author's method of dealing with foreign bodies of very large size in the œsophagus. In this particular case (see Fig 32) selected for illustration œsophagoscopy prior to admission failed because nothing short of fatal traction could bring the artificial denture through the obstructing folds (shown in illustration A) which had been allowed to collapse in around the forceps by withdrawing the œsophagoscope at a higher rate of speed than that of the forceps and foreign body. By bringing œsophagoscope forceps and foreign body all out together as one piece the foreign body close against the tube mouth (B) a heavy collapse of folds is impossible. Any fold that catches the foreign body can be readily manipulated out of the way by the tip of the tube mouth. See also Figs 20 and 21.

three elements, foreign body, bronchoscope and forceps, together as one piece, so that all come out together. If this is not done the foreign body trailing beyond the tube-mouth, as it is almost certain to do if each instrument is held independently, will permit glottic closure on the forceps cannula before

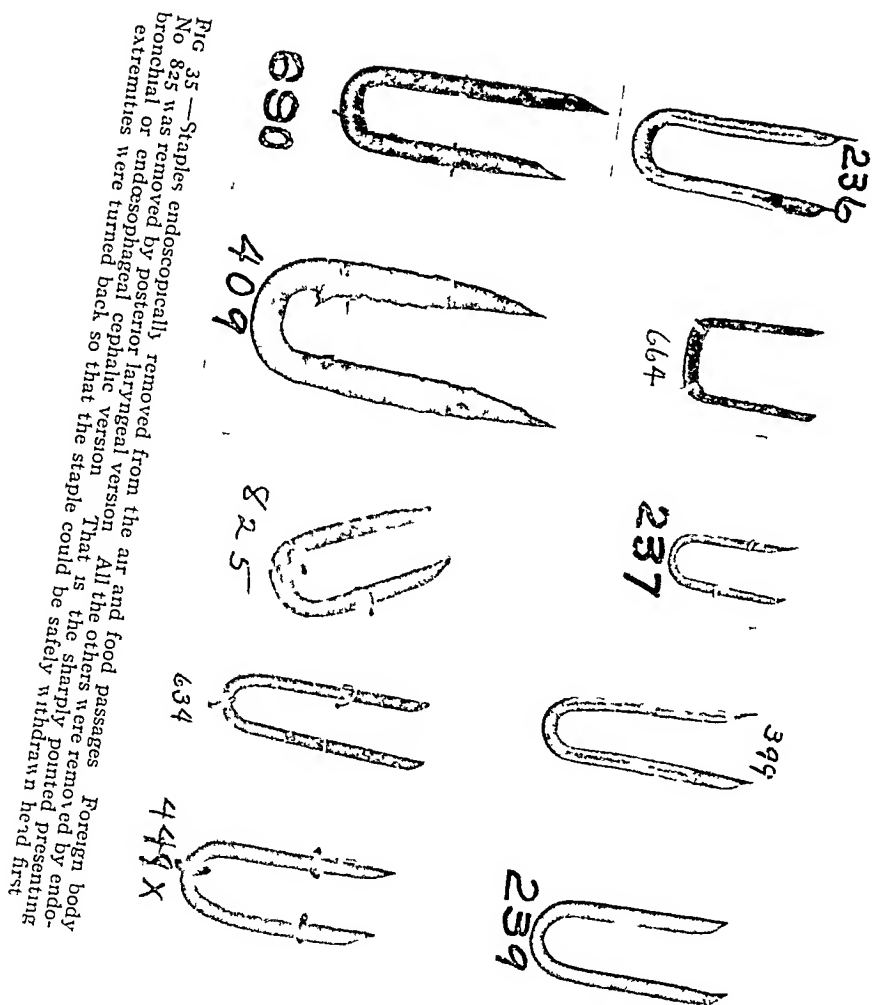


Fig 35—Staples endoscopically removed from the air and food passages Foreign body No 825 was removed by posterior laryngeal version All the others were removed by endobronchial or endoesophageal cephalic version That is the sharply pointed presenting extremities were turned back so that the staple could be safely withdrawn head first

Fig 36—The safety-pin problem complicated by a button The button and pin had been swallowed together the metallic ring of the button was on the pointed branch of the pin the entire ring of the esophageal wall and having hooked itself under the tightly constricted cricopharyngeus muscle The keeper end of the tightly con size of the patient an infant aged 10 days The problem was solved and the pin was removed in one minute by the method illustrated in Fig 12

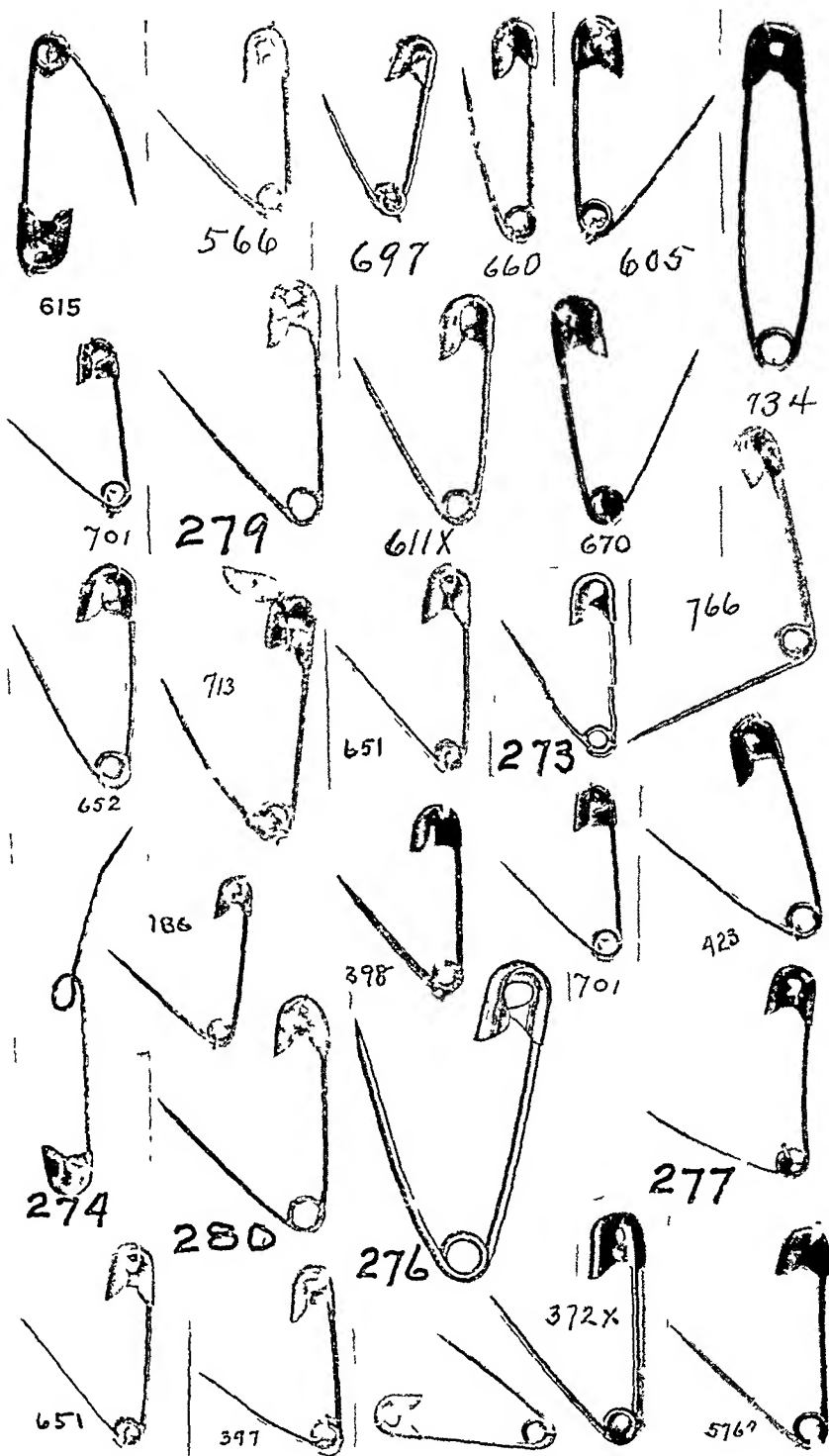


FIG 37—Some of the safety pins removed from the air and food passages at the Bronchoscopic Clinic by endoscopy through the mouth without anaesthesia. Some of the open pins were closed before removal, others were removed by the point protecting method and still others were removed by endoesophageal or endogastric version.

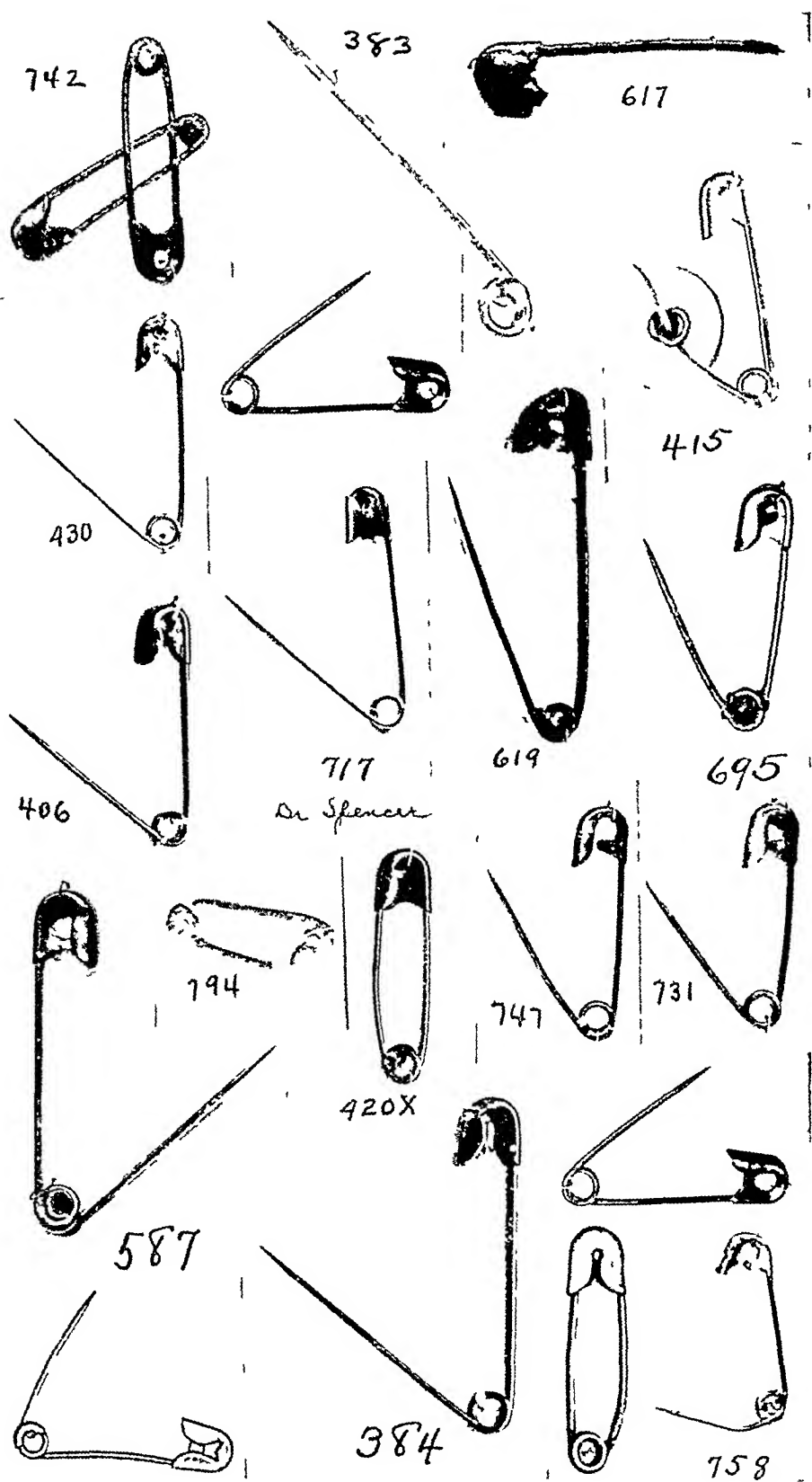


FIG 38—Some of the safety pins removed from the air and food passages at the Bronchoscopic Clinic by endoscopy through the mouth without anæsthesia. Some of the open pins were closed before removal others were removed by the point-protecting method and still others were removed by endoesophageal or endogastric version

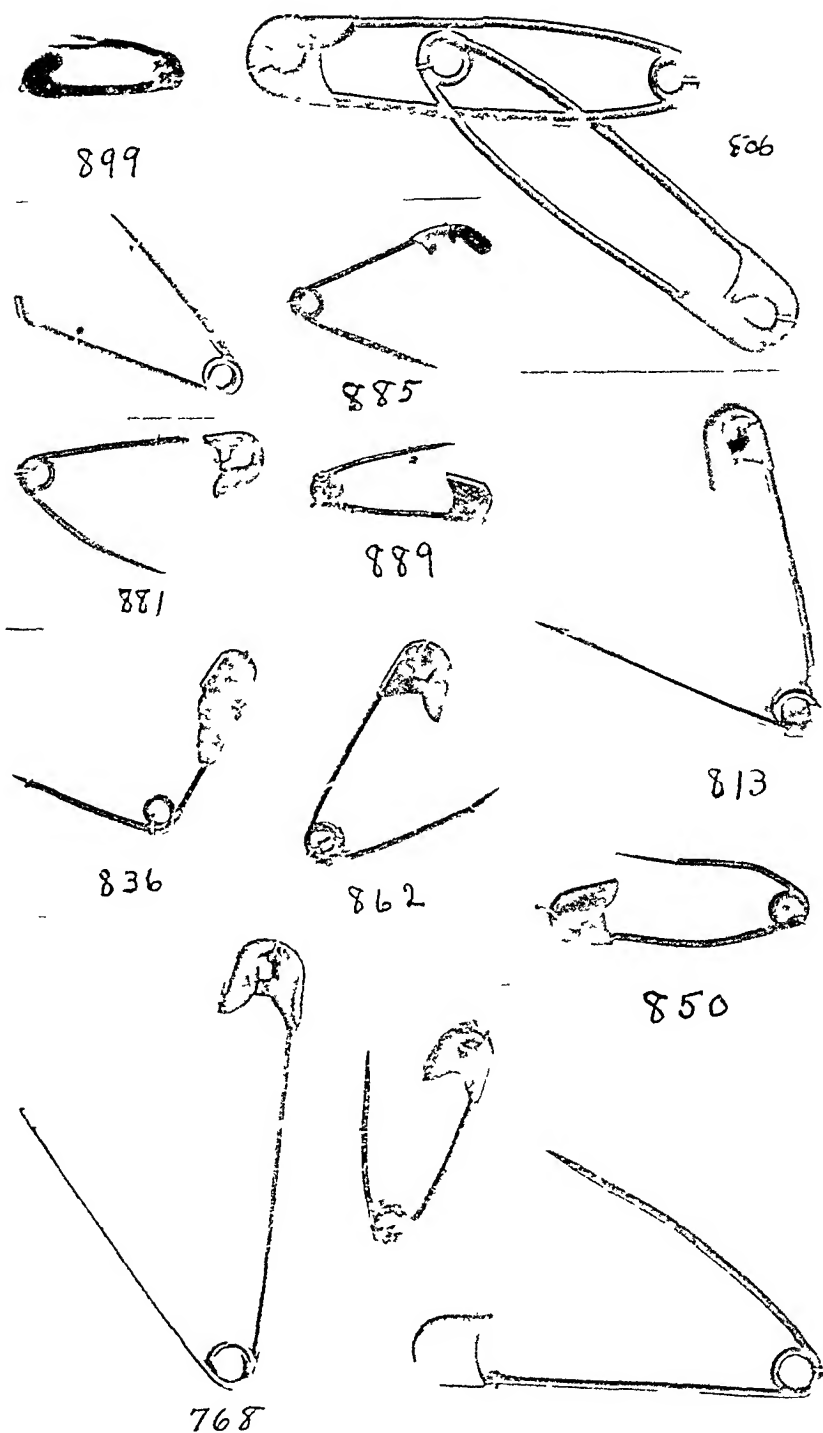


FIG. 39.—Some of the safety-pins removed from the air and food passages at the Bronchoscopic Clinic by endoscopy through the mouth without anæsthesia. Some of the open pins were closed before removal, others were removed by the point-protecting method and still others were removed by endoesophageal or endogastric version.

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the foreign body reaches the glottis. The almost inevitable result is the stripping off of the foreign body (Fig 21)

14 Before inserting forceps, the distance from the tube-mouth to the foreign body should be estimated. The jaws of the forceps going down the tube show in black silhouette against the lighted field. When the jaws reach the light they show up brightly lighted. This localization leaves only the distance from the tube-mouth to the foreign body to be estimated by depth perception.

15 Until the glint of light on the forceps is seen the jaws should never be allowed to open, and in many cases they should not be allowed to open until the intruder is reached. They should, however, open before the intruder is touched and thus displaced.

16 Peanut kernels and similar friable objects must not be grasped so firmly as to crush them. To do this and yet hold the foreign body sufficiently

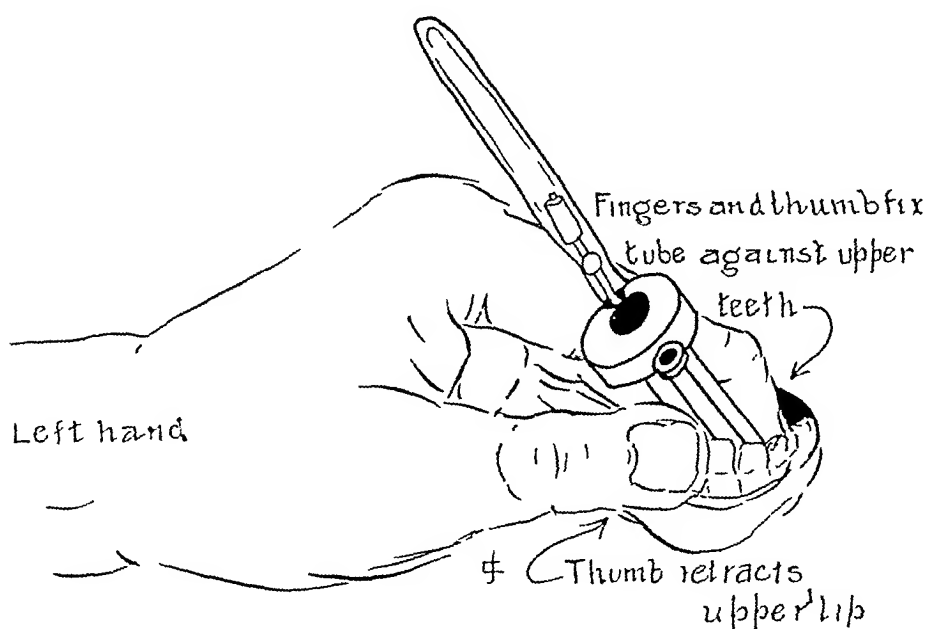


FIG 34—Having found the foreign body and developed the proper presentation, by version or otherwise, the tube is fixed against the upper teeth with the thumb and finger of the left hand as here shown in order to maintain the presentation until forceps are inserted and the foreign body is properly grasped according to the mechanical problem presented. Neglect of this precaution is the cause of many failures.

firmly to withdraw it requires the training to be acquired only by the preliminary practice in crushing hundreds of peanut kernels with the bronchoscopic forceps. Allowance must be made for variations in resistance to crushing according to the degree of roasting and to a slight extent the degree of maceration.

17 Because of the limitations imposed by the necessity of working at a distance through a tube with one eye only, training of the eye and the fingers to the peculiar, ocularly guided, bimanual manipulations of forceps and tube are necessary to a large percentage of successes. As with all other manual things the knowledge of how to do them is not enough. Nerve-cell habit

should be established by practice until the manipulations are made subconsciously as with the knife and fork in eating

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THE SURGICAL TREATMENT OF PERNICIOUS ANÆMIA*

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THE blood has offered many interesting, often elusive, problems to the profession, none perhaps more so than the anæmias grouped under the term "pernicious" anæmia

In general two types of the anæmias are classified under the above, the aplastic anæmias and the hæmolytic anæmias. By aplastic anæmia is meant an anæmia in which there is decreased blood formation, aregeneratory anæmias (Barker). Vogel regards this form as a hemorrhagic or purpuric disease, that it is "primarily a leucomyelotoxicosis," and states that it can be produced experimentally by benzene poisoning.

The hæmolytic anæmias are of a number of types and are characterized by an excess of blood destruction over blood regeneration. The blood destructive agent for certain of the hæmolytic anæmias is more or less definitely known and the following groups are recognized:

- 1 Anæmia due to intestinal parasites (such as *Dibothriocephalus latus*, in which the hæmolytic agent is cholesteryl oleate). Mayo (ANNALS OF SURGERY, vol lxxiv, 1921, p 359) reports some observations by Logan from the Mayo Clinic upon the *Balantidium coli* as a possible cause of pernicious anæmia.

- 2 The hæmolytic anæmias of syphilis and of carcinoma.

- 3 The hæmolytic anæmias of the puerperium in which the hæmolytic agent is found in the placenta.

- 4 The hæmolytic anæmias due to such chemical poisons as potassium chlorate, nitrobenzene, phenyl hydrazin, the amino acids (Iwao), and oestrin (Seyderholm).

- 5 The hæmolytic anæmias classified as hæmolytic or acholuric jaundice which appear in both the congenital form (Chauffard-Minkowski) and the acquired form (Hayem-Widal). In both these varieties the hæmolytic agent is unknown, but it has been fairly definitely demonstrated that the pathological hæmolysis is closely related to some action on the part of the spleen.

In addition to the above there is still a large group of hæmolytic anæmias for which no definite causative agent can be said to have been found, and these may be classified as the Addison Biermer types of pernicious anæmia. It would be infinitely better to group them all under the term hæmolytic anæmias of unknown origin, to await the time when the etiological factor responsible for their existence has been recognized.

The diagnosis of "pernicious" anæmia may be made from the history of gradually progressive weakness with a marked anæmia in the absence of any

* Read before the New York Surgical Society October 12, 1921

recognizable disease of the internal organs A definite diagnosis, however, depends upon the blood findings, viz (Cabot)

1 A reduction of the number of red cells, usually below 2,000,000 per cubic millimetre

2 The high color index of the red cell

3 A subnormal or normal white cell count

4 The presence of abnormally large deformed or deeply staining red cells, some of which may be nucleated

Cabot separates the aplastic anæmias from the general type and in his experience the aplastic anæmias occur chiefly in young women usually before the thirty-second year, run a rapid course and end fatally within a short period The other type runs a more chronic course, is prone to remissions, and occurs much more commonly in men than in women

Barker,¹ describing the Addison Biermer or hæmolytic type, considers the blood picture of this type as sometimes indistinguishable from the hæmolytic anæmias of known origin He states that (1) it is commonest in people of middle age, (2) affects both sexes in about equal numbers, (3) the onset is insidious, the patients complaining of weakness without apparent cause, of increasing pallor (with straw-colored tint to the skin), of dyspnœa, of gastro-intestinal disturbances, and of nervous symptoms, (4) the urine is usually high colored and contains an increased amount of urobilin, (5) there is always gastric anacidity, and (6) the blood changes characteristic of a hæmolytic anæmia are demonstrable (reduced red count, anisocytosis, poikilocytosis, high color index, often regeneration signs, including nucleated red cells, polychromatic red cells and basophilic stippling, moderate leucopenia with relative lymphocytic increase, and a diminished number of platelets) There is often a little fever, but not always He also states that the prognosis should be guarded, as sooner or later a relapse occurs which does not yield to treatment and death occurs

In dealing with a disease in which so many factors enter as possible causes, it necessarily follows that many varieties of treatment have been tried, all with more or less efficacy in some forms I shall have to take for granted that the various hygienic, dietetic and medicinal forms of therapy are sufficiently well known to be omitted from this paper

The forms of treatment which are of interest to the surgeon are blood transfusions the eradication of foci of infection, and splenectomy

MacKenzie² points out that medical treatment has been in advance of knowledge, that treatment has been empiric, even experimental, and that knowledge has come later from the results of the attempts to palliate or cure the diseases of man In no other field is the above more true than in the therapy of the anæmias

Transfusion of the human blood from a selected donor whose blood is compatible has now become an established therapeutic agent, thanks to the work of Landois,³ Jansky⁴ and Moss⁵ The methods of transfusing the blood of the selected donor are numerous, but the two forms chiefly used

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are (1) the direct transfusion of the undiluted blood by the syringe method popularized by Lindeman, and (2) the citrate method of Lewisohn

The quantity of blood to be transfused is still a question for discussion. If the theory that the blood introduced from the donor stimulates the blood-forming organs, then small transfusions often repeated would seem the method of choice. If the new blood brought into the body by the transfusion brings some substance that inhibits or counteracts the action of some blood destructive agent, then the quantity would depend more or less upon the state and condition of the patient, and would have to be larger than the dose used to stimulate the blood-forming organs and might be said to be comparable to the use of the varying quantities of antitoxin in such diseases as diphtheria. By that I do not mean that there is any analogy between the two processes, but that larger quantities would be required for the severer cases.

If the theory that the introduced blood carried the donor along until his fatigued blood-forming organs had time to recover and to again begin to function properly, then the larger doses would seem to be indicated.

In this connection the life of the transfused blood-cell in its new surroundings may throw some light. In one of my cases of pernicious anæmia in which repeated small transfusions were done, it was possible to distinguish the introduced red cell for from fourteen to sixteen days at first. Later it began to disappear on the twelfth day, then the eighth to the ninth day, and at last could not be followed after the fourth day. The improvement in the condition of the patient and in the blood count coincided very closely to these periods, lasting three weeks at the beginning before a slump occurred and at last only four days when the case finally resulted fatally.

Mayo,⁶ quoting from an unpublished paper by Ashby from the Mayo Foundation, states that the red cells of the transfused blood in persons not suffering from idiopathic blood diseases may last from one to three months.

As yet no solution as to the quantity of blood to be transfused has been reached. It has been my experience that often repeated small or moderate transfusions have been as successful as the larger ones and are less apt to cause unpleasant reactions in either the donor or the donee.

Blood transfusion has then become an added therapeutic agent in pernicious anæmia. It is a lift, acts as a temporary stay, but has not yet cured the disease. One can readily understand why that is true when we realize that this is one of the therapeutic experiments spoken of by MacKenzie to palliate human suffering.

With the recognition of the grave systemic effect of focal infections and the part played by these infections in certain diseases and the empiric effect of the removal of these infected areas in such conditions as arthritis, foci of infections are now mercilessly eradicated in anæmic patients, based upon the theory that these infections either stimulate blood destructive agencies, or that the organisms themselves form a hæmolyisin which gradually gains headway

against blood formation, or like certain poisons, benzol for example, inhibit or actually destroy the blood-forming organs

Barker, for example, feels that the treatment of infections of the gums and teeth in patients with pernicious anæmia have been so frequently followed by rapid improvement that he agrees with William Hunter that these infections play a very important rôle in the production of pernicious anæmia

It is not uncommon to find focal infections in individuals at forty or over, but if the organism in this infected area is not of the hæmolytic strain can it be said to be more than a coincidence?

I am heartily in accord with the view that focal infections should be eradicated in anæmias, but the organism or organisms grown from the infection should have definite hæmolytic properties before they can be considered etiological agencies. The bacteriologist will undoubtedly give us much valuable information, and the field of investigation of the action of the organisms thus obtained may give much information about some of the remittent forms of pernicious anæmia which we now see

Percy⁷ reported twenty-four of the thirty-seven cases he had operated upon for pernicious anæmia, and reports the cultures in nine of his cases. The hæmolytic streptococcus was grown from the spleen in three cases, from other organs removed at the same time in seven out of the nine cases. He believes that, "while it is impossible to state anything definite concerning the relation of these various infections to pernicious anæmia, it is an interesting observation from the standpoint of etiology and treatment." He also believes that the rational treatment should consist of three main steps: (1) Massive step-ladder transfusions of the whole blood (2) Splenectomy (3) Removal of all possible sources of infection

In none of my cases was any organism grown from the spleen, and with the exception of one case with a few suspicious teeth were there any foci of infection discoverable

Eppinger,⁸ Descatello,⁹ and Klemperer and Hirschfield¹⁰ used splenectomy as a therapeutic measure in pernicious anæmia. Each observer was prompted to use this method because of certain observations made after splenectomy for other conditions. Eppinger noted that splenectomy was followed by a diminished output of urobilin and by other evidences of decreased hæmolysis. Descatello, by noting the improvement which followed splenectomy in hæmolytic jaundice, and Klemperer, by noting that polycythæmia sometimes followed splenectomy for rupture of the spleen, tried splenectomy for pernicious anæmia and reported marked improvement of their cases following this procedure

My experience covers seven cases of splenectomy done for pernicious anæmia, with three improved for periods of from one to four years, and three cases in which death resulted within a year following the operation, and one too recent to state the final outcome

In another paper, in discussing the effect of splenectomy in pernicious anæmia, I wrote "The anæmias in which there is a disturbance of blood for-

mation, if they can be definitely classified and recognized, cannot be benefited by splenectomy, inasmuch as the trouble does not lie in the spleen, but in the blood-forming organs

In the other type, *i e.*, those showing increased blood destruction, many factors as yet undetermined must be solved before the position of splenectomy as a therapeutic measure can be settled. At one end of this group one finds cases in young individuals, under forty, in which the blood picture is somewhat atypical, in which blood destruction occurs in crises (hæmatogenous crises) with periods of remission, and who have a definite enlargement of the spleen. In this variety splenectomy brings about a result comparable to that seen in the acholuric or hæmatogenous jaundice cases, and the enlarged spleen seemingly has some increased action in the process of blood destruction and its removal is followed by definite improvement if not by an actual cure.

Between these two extremes (the aplastic anæmias and the type comparable to the hæmatogenous jaundice group) is a middle group in which manifestations of inhibition of blood formation or increased blood destruction occur either separately, in conjunction, or in sequence. Just when an individual with an increased blood destruction may begin to show aplasia as a result of this constant blood destruction, or whether the factor producing the hæmolysis may likewise produce an inhibition of blood formation coincident with the increased destruction, or whether the inhibition of blood formation may produce an imperfect formation of the red cells which permits of this ready destruction, are problems to be solved. (The effect of splenectomy on the normal individual and in certain pathological conditions ANNALS OF SURGERY, May, 1918)

In a condition with so many factors which may influence our decision as to treatment, what clinical findings are there which would suggest that splenectomy might be of value? The following have impressed me as of importance.

Age. Individuals under forty-five, with an anæmia of the hæmolytic type, with attacks of blood destruction (hæmatogenous crises), with periods of remission between these crises.

The presence of a palpable spleen. The spleen is usually considered as not palpable in pernicious anæmia. The size of the spleens reported by Kumbhaar¹¹ for eighty-nine cases was, normal 28, slightly enlarged forty-one, considerably enlarged twenty. That is there was enlargement of the spleen in over 65 per cent of the cases. He also states that the better postoperative results were obtained with the enlarged spleens. The spleen was palpable in three of my patients, questionably palpable in two, and not felt in two. The palpable cases were the largest and the non-palpable, while increased in size, were not large enough to be felt. In the other cases there was a difference of opinion among those who examined the patients as to whether the spleen could be felt or not. In all of my cases the spleen was larger than normal (265 to 500 gms.)

If the spleen is felt it is a very definite indication for removal, in my experience

The blood findings Lukis believes that the presence or absence of the vital staining cell is of prognostic value, *i e*, in the cases of anæmia in which vital staining red cells are absent, the prognosis is bad for any therapeutic measure, and conversely when they are present or increased in number the prognosis is better. It would seem wiser from the writer's limited experience to go even further than this, *i e*, when the vital staining cells are absent or present only in a little less than the normal ratio, splenectomy can be of little or no help. If the vital staining cells are present in an increased ratio above the normal, splenectomy should be considered.

If the blood findings show that the reticulated cell is present in less than normal ratio, blood transfusion should be done. If this increases the number of the reticulated cells, it is a help in deciding for splenectomy. If the cells are not increased by this means, splenectomy does not help.

After the splenectomy, if there is a marked increase in the reticulated cell, the case is more likely to benefit by the operation.

Minot¹² considers that the blood platelets give the best information as to bone-marrow activity. If they are absent or present in small numbers the bone-marrow is deficient in action. If large numbers are present the bone-marrow is active and this latter group improve most by splenectomy and transfusion. Minot, furthermore, found that the cases submitted to splenectomy benefited more and remained well longer after blood transfusion than those in which blood transfusions alone were used.

In my experience the reticulated cell has been of more help than the platelets, but my series is entirely too small to be of any great value in arriving at a decision.

Furthermore, those cases which show improvement following a transfusion and who do not return to quite the low ebb that existed before, seem to be benefited by splenectomy.

Fragility of the red cell as tested by hypotonic salt solution. Hæmolysis of the red cell by this method varies for the different types. If the red cell is less resistant than normal before splenectomy the patient will be improved by the operation, and the greatest improvement in my series occurred in the case with the most fragile red cell.

Splenectomy is contraindicated in the elderly individuals, in the cases with spinal cord symptoms, and in the aplastic cases.

In the others I believe with Percy¹⁸ that transfusion, the eradication of foci of infection and splenectomy are valuable adjuncts to our present therapy.

When all our fragmentary knowledge is placed together, it becomes increasingly more evident that the anæmias are as yet but little understood. Our knowledge will be augmented by the study of all the factors above enumerated, but will require the assistance of all the laboratory, technical and chemical skill at our command to decide upon the method of treatment to be used for the given case.

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If splenectomy is to be considered I would make a plea for the early arrival at that conclusion, as the early cases do much better than those in which splenectomy is done as a last resort

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WOUND EXCISION AND EARLY RECONSTRUCTION IN THE TREATMENT OF COMPOUND FRACTURES*

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THE important relation between wound excision and early plastic surgery was constantly in evidence with those assigned to reconstruction hospital service during the world war. Many badly mangled extremities were saved, with all structures essential to function preserved, but were almost useless because of paralysis, stiffness or contracture. This was inevitable with the difficulties unavoidable in military surgery, but much better results should be expected from similar injuries in civil practice.

Observation of conditions in a number of general hospitals in surgical centres leads to the feeling that we are not profiting by the lessons of the world war in the management of these conditions as we should. Of course, this is not true of all hospitals, but could not many hospital-bed days, much dressing material and time of internes and nurses, to say nothing of valuable lives and limbs, be saved by the adoption of the standard instructions to the resident staff as to wound excision, methods of disinfection and general measures of reconstruction by the surgical services in charge of many members of this Association? Frequently we are inclined to ask, what percentage of industrial and other accidents could have been more efficiently treated by the better surgical teams of war times? Yet such team-work and surgical care is much more readily possible in almost any of our home hospitals than in military practice in time of war. War experience showed clearly that much of such surgery need not be done personally by surgeons in charge, but could be delegated to well-trained younger men fairly instructed how to carry out the work. The yearly increasing thousands of accidents resulting from modern traffic and industrial conditions makes the most efficient management of such injuries a problem of vital importance, for the numbers in loss of life as well as function equal or exceed those in any field of pathological surgery.

As urged in a paper published over twelve years ago,¹ the most important consideration in the management of compound fractures is still the wound of the soft parts. "If our wound is aseptic, tetanus and blood poisoning are impossible, bony union and a movable joint (Figs 1 and 2) are favored, osteomyelitis will not develop, and a useful, if not perfectly normal, extremity

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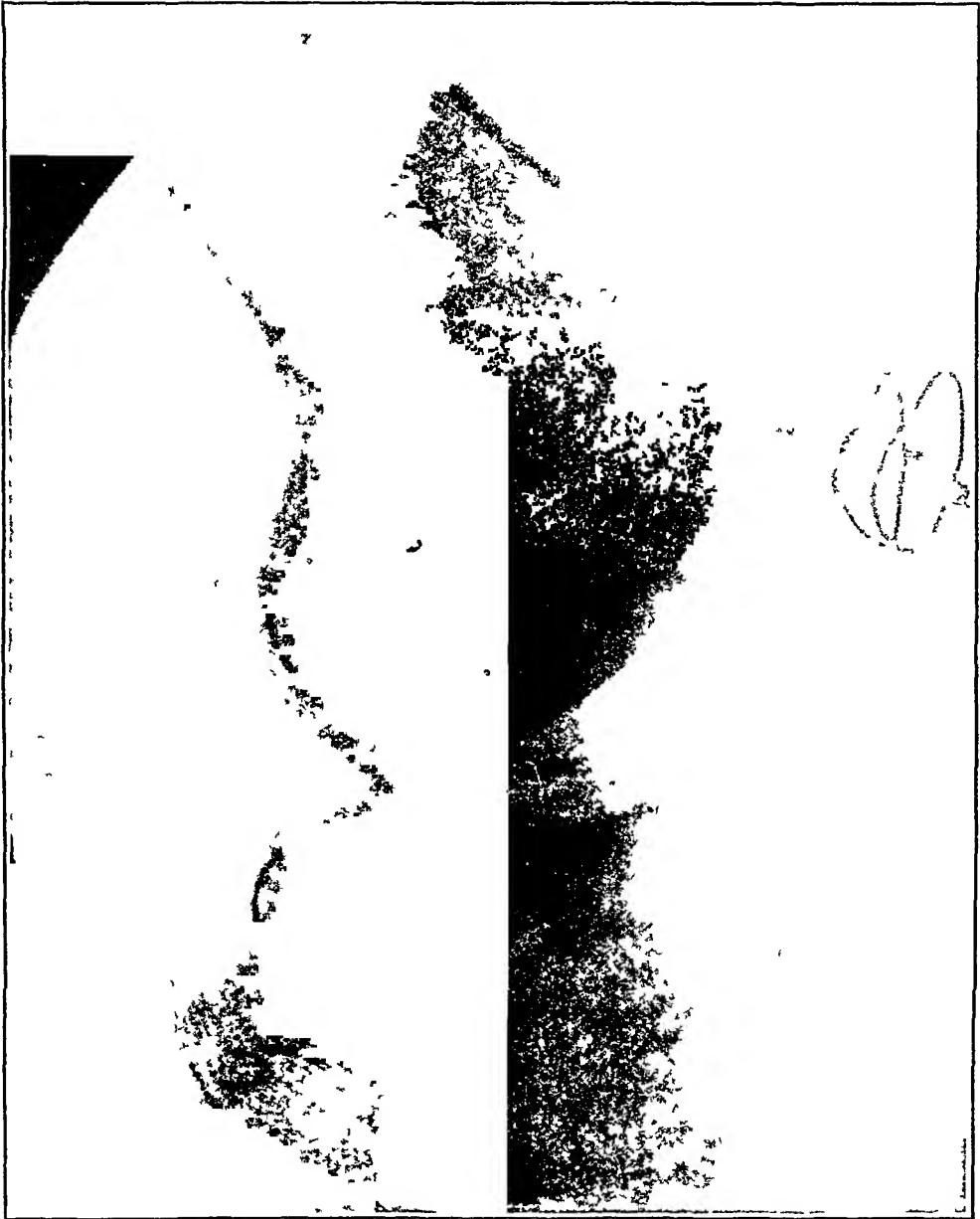


FIG 1 —Wound excision operation performed 1905. Compound comminuted fracture of patella. Kicked in the knee by a horse. Wound contaminated with horse manure. No trouble from silver wire sutures five years after operation.



FIG 2—Perfect flexion of knee both voluntary and passive in fracture of patella shown in FIG 4 Patient able to do all kinds of farm work without any disability

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will usually be saved " The importance of various measures of reconstruction is equally important Unless we can save or restore the main nerve or blood supply the extremity must be sacrificed The importance of preserving the function of tendons and certain joints is almost equally great The ideal, where possible, is to carry out necessary reconstruction procedures at the time of excision

With regard to wound excision itself the question arises, were the best methods used where possible during the war, and are they now being used? To help throw light on this question, some experiments were done in the laboratories of physiology, bacteriology and histology of Cornell University and New York State Veterinary College I take this opportunity to acknowledge my indebtedness to Profs Sutherland Simpson, B F Kingsbury and V A Moore and their associates, Prof H J. Milks and Doctors Carpenter and Hitchcock The problems which we undertook to solve were as follows:

- 1 Is it possible to disinfect an extensively infected wound, especially the external wound, thus preventing contamination of the clean excised area during excision?

- 2 What is the relative value of various antiseptics (*a*) in killing bacteria, and (*b*) in penetrating lacerated and contused tissue?

- 3 Is it possible so to stain lacerated tissue as to be of material help in outlining the injured from the uninjured tissue?

First. In the attempt to solve the first question as to the disinfection of infected wounds, animals which were used in experimental physiology were first killed with an anæsthetic Extensive lacerated and contused wounds were then made by driving a rusty bolt into the tissues with a mallet, by crushing the extremities in a vise against a rough stone, and by tearing with a large rusty hook. The rusty bolt, hook and stone used in making these wounds were all thoroughly contaminated with a culture of a very resistant spore-forming organism To attempt to disinfect these badly lacerated, contused and definitely contaminated wounds the following antiseptics were tested (*a*) Saturated solution of permanganate of potassium (this was used because of its oxidizing value with special reference to the anaërobic spore-formers), (*b*) pure carbolic acid solution, (*c*) strong formaldehyde solution, (*d*) Harrington's solution (1 to 500 bichloride of mercury in 90 per cent alcohol with 2 per cent. hydrochloric acid) and dichloramine-T 5 per cent The wounds were thoroughly swabbed with one of the above strong antiseptics The results were as follows.

Wound No. 1 Potassium permanganate Stone All three tubes show heavy growths of B Chauveau

Wound No 2 Carbolic acid Bolt All three tubes show growths of organism No 1, three colonies, No 2, nine colonies, No 3, twelve colonies

Wound No 3 Harrington's solution Hook Two tubes negative, one tube shows one colony

Wound No 4 Carbolic acid Bone crushed Three tubes show growths of organism No 1, three colonies, No 2, eleven colonies, No 3, sixteen colonies

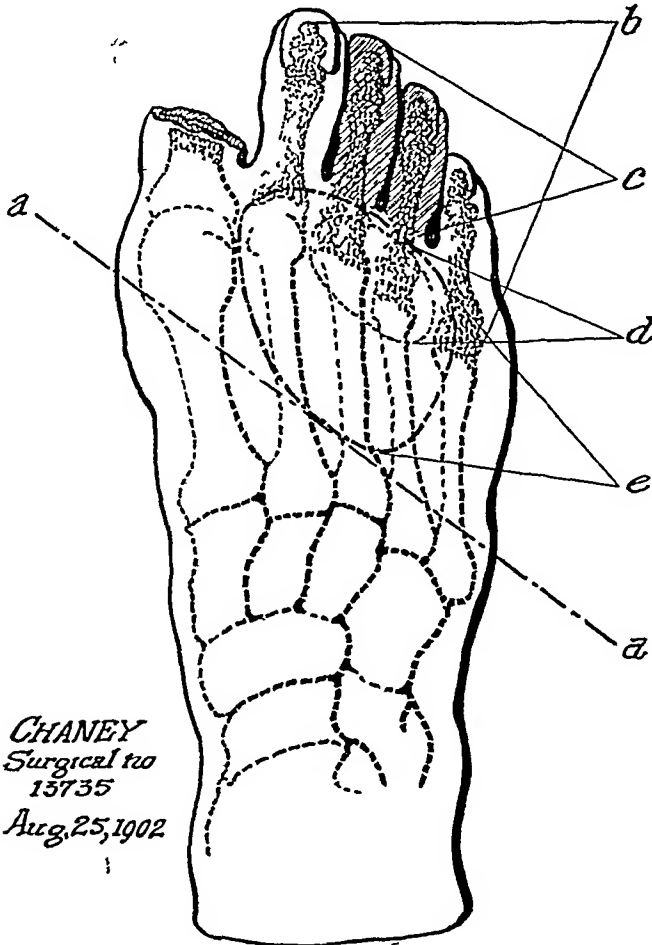


FIG 3 —DIAGNOSIS —Right Foot crushed with railway car wheel Two middle toes black and gangrenous a Direction in which wheel passed b Area of crushed bone c Area that was gangrenous d Area on plantar side of foot where soft parts were entirely destroyed e Area on dorsal side of foot where skin was stripped off and destroyed and tendons exposed

Wound No 5 Formaldehyde Bolt No 1, negative, No 2, one colony, No 3, heavy growth throughout the tube

Wound No 6 Dichloramine-T Bolt No 1, sixteen colonies, Nos 2 and 3, heavy growth throughout the tube

The relatively small series of tests indicated superiority of Harrington's solution and considerable value for formaldehyde solution and pure carbolic acid, but it seems that permanganate of potassium cannot be relied upon in spite of its strong oxidizing value and dichloramine-T also did not give good results

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Second To determine the extent of penetration of the antiseptic into lacerated and contused tissue, frozen sections of excised tissue were made and examined, which showed that, while the degree of penetration is not

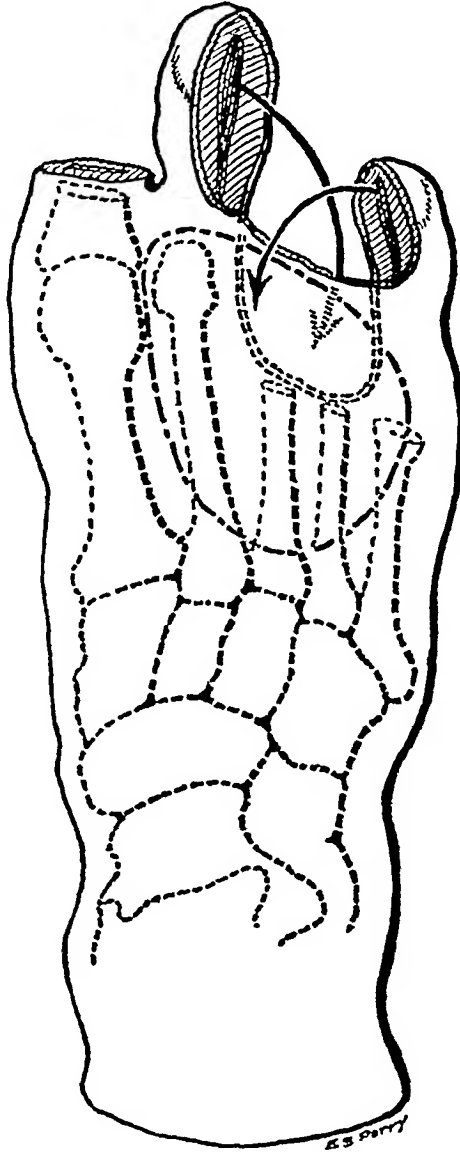


FIG 4 —OPERATION—Amputation of 1st and part of 2nd joint of big toe and of 3rd and 4th toes Removal of crushed bone of 2nd and 5th toes Soft part of 2nd and 5th toes saved for flaps

great, it is probably sufficient to take care of practically all bacteria in case the infection has not been in contact with the tissues too long, giving the bacteria an opportunity to spread by lymphatic or blood channels

Third To determine the possibility of outlining the injured from the uninjured tissue the following stains were used Strong solutions of acriflavine, methylene blue and hot saturated solution of permanganate of potassium The distinction between stained and unstained tissue was clear enough

with any of the stains to be of great help in dissecting out the injured area, but the permanganate solution gave easily the best results. These experiments with stains merely confirmed similar ones carried out with medical officers at Ft Riley and the results of clinical experience in civil practice in staining lacerated wounds, sinuses and fistulous tracts for excision. Anyone who has seen the difference between excision of an unstained fistulous tract and one stained to stand out from the surrounding tissues as clear as a shoestring would not be difficult to convince of the value of tissue-staining in outlining irregular penetrating wounds for excision. These methods I have used and advocated for fifteen years and am certain will prove a help to any not using them who will adopt them.

Local anæsthesia if properly used is most satisfactory in the vast majority of cases. It was used in a large percentage of the reconstruction work at General Hospital No 26, Ft Des Moines. Wound excision and reconstruction measures in many cases are very time-consuming, and by the use of local anæsthesia the risks are greatly reduced. Crile has demonstrated the value of local anæsthesia in combination with gas-oxygen in preventing shock, but if properly used, local anæsthesia alone gives relief from pain which is satisfactory to the patient. As is desirable in any line of surgery, so with local anæsthesia, it is necessary to get the best results to study the methods and observe the work of those accustomed to its use. Those who have attempted local anæsthesia in major surgery without such study and observation have frequently failed to get relief of pain and discarded the method without a fair trial. A minority have used local anæsthesia for many years and have proved its value beyond question in the class of cases which we are now considering. In both civil and military surgery it has the advantage of saving anæsthetic drugs and the services of a special anæsthetist for the administration of the anæsthetic. In many cases of compound fracture of the extremities it is possible to block the nerves supplying the field with relatively little anæsthetic solution. Both in this way and in certain other cases, by the massive infiltration, as used by Harr, I have succeeded in getting satisfactory anæsthesia. It is true that in certain very extensive and tedious cases the inhibition of the patient partially wears out after an hour or two, but a great deal of time under general anæsthesia can almost invariably be saved.

Skin Grafts In the case of superficial injury, when no important structures are exposed, *immediate* or early skin-grafting saves a great deal of time in healing. The modified autogenous graft, a name which I coined ten years ago for want of a better,² requires only a small superficial denudation which rapidly heals. The use of local anæsthesia makes this a very minor procedure in most cases, and because of the relatively small amount of skin required it is generally unnecessary to go to distant parts of the body to

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get skin The grafts resemble the "deep, small grafts" of Staige Davis, but the method of using them seems to me simpler A line of skin is infiltrated and the skin pinched up in a roll between the thumb and finger of the operator and assistant A long strip of skin, thin at the edges but thick in the middle, can then be cut easily with any sharp scalpel and snipped off in pieces one-

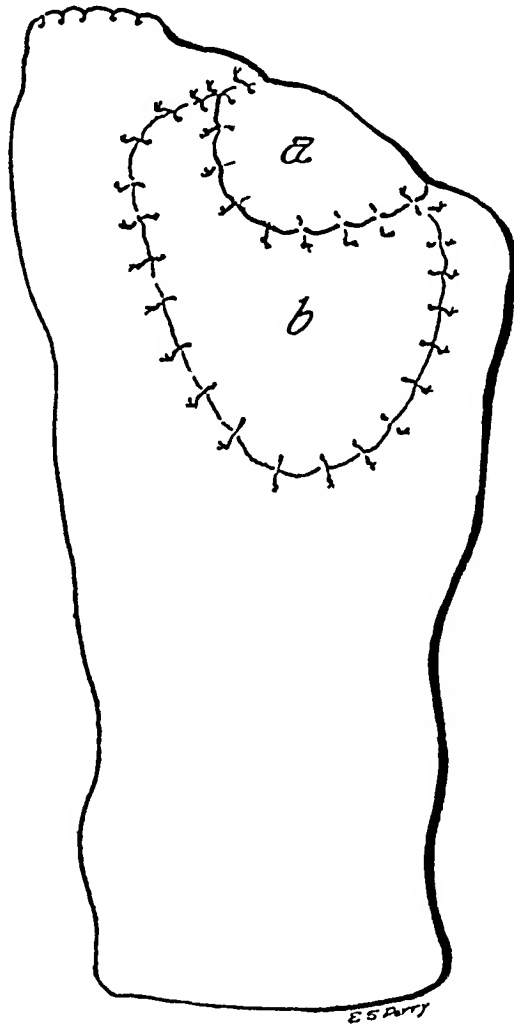


FIG. 5—*a* Soft parts of 5th toe turned over and across as flap to cover over ends of 3rd and 4th metatarsal bones *b* Skin graft from thigh over defective area

half inch or less square (These are supplied as islands about one-quarter inch apart to the surface it is desired to cover and usually rapidly grow together) With free drainage and the use of mild antiseptics the grafts usually hold even in the presence of considerable infection

Flaps When nerve trunks, tendons and joints are exposed, skin grafts do not offer sufficient protection A pedicled flap of skin with a little underlying subcutaneous fat gives the best results If there has not been too great local destruction of the skin the flap may be turned from the immediate vicinity In case of extensive destruction of soft parts of the arm, a flap

from the chest or, less desirable, the abdomen may be used. Pedicled flaps turned from the chest or upper abdomen are not used as frequently as they might be with advantage in the management of injuries with considerable loss of the soft parts of the hand or forearm. A full-thickness flap of almost any size or shape with ample subcutaneous fat can be readily obtained from the chest or abdomen without causing later disability. The flap becomes well established in about eighteen days, when it can be cut free and adjusted if necessary. As a substitute for plaster-of-Paris or other rigid dressing, the use of wide adhesive strips and small pillows under a binder to support the arm we found in military surgery much more comfortable for the patient, and the fixation all that was necessary for healing-in of the flap (Fig 10). The slight change of position from occasional adjustment of the binder and very elastic support of this fixation made the patients so comfortable that complaints with regard to the dressing were unusual, in great contrast to plaster-of-Paris. The defect in the chest-wall can be closed with tension sutures of silkworm gut through heavy rubber tubing, or something similar, to prevent cutting of the sutures.

Tendons—Extreme disability always follows compound fractures of the hand or forearm in case prolonged suppuration involves the tendon sheaths. If by thorough wound excision or early effective disinfection by Carrel-Dakin treatment or other antiseptics it is possible to get fairly early healing, the results of injuries involving tendons are often surprisingly good. In dealing with compound fractures of the fingers, hand or arm, an incision along the side following up the divided tendon gives better results than an incision, as so commonly placed, directly over the tendon. With incision directly down through the tendon sheath it frequently springs out and becomes adherent, and in many cases the scar tissue alone gives a high degree of disability. Better still, an incision placed transversely in the line of the normal skin-folds gives more satisfactory results than a longitudinal incision if sufficient exposure can be obtained in this way. Mattress stitches in dealing with thin tendons or muscles usually hold, while simple interrupted stitches frequently cut out. So many failures to secure union of tendons by the use of catgut sutures have come to my notice that I feel that the use of silk or some other unabsorbable material should be urged. In case a tendon has retracted far up, it is frequently possible to reach the end with a Halsted mosquito clamp inserted into the tendon sheath, grasp it and draw it down, a much more satisfactory method than division of the sheath. Splinting or other measures necessary to hold the parts in such position as to avoid tension is desirable but should not be continued long. Usually I begin some movements at the end of a week or two, at the latest three weeks. In case repair is not possible until weeks or later, the retracted upper end of the tendon is usually adherent to the sheath, making the opening of the sheath and separation of adhesions unavoidable. In such cases, bowstring

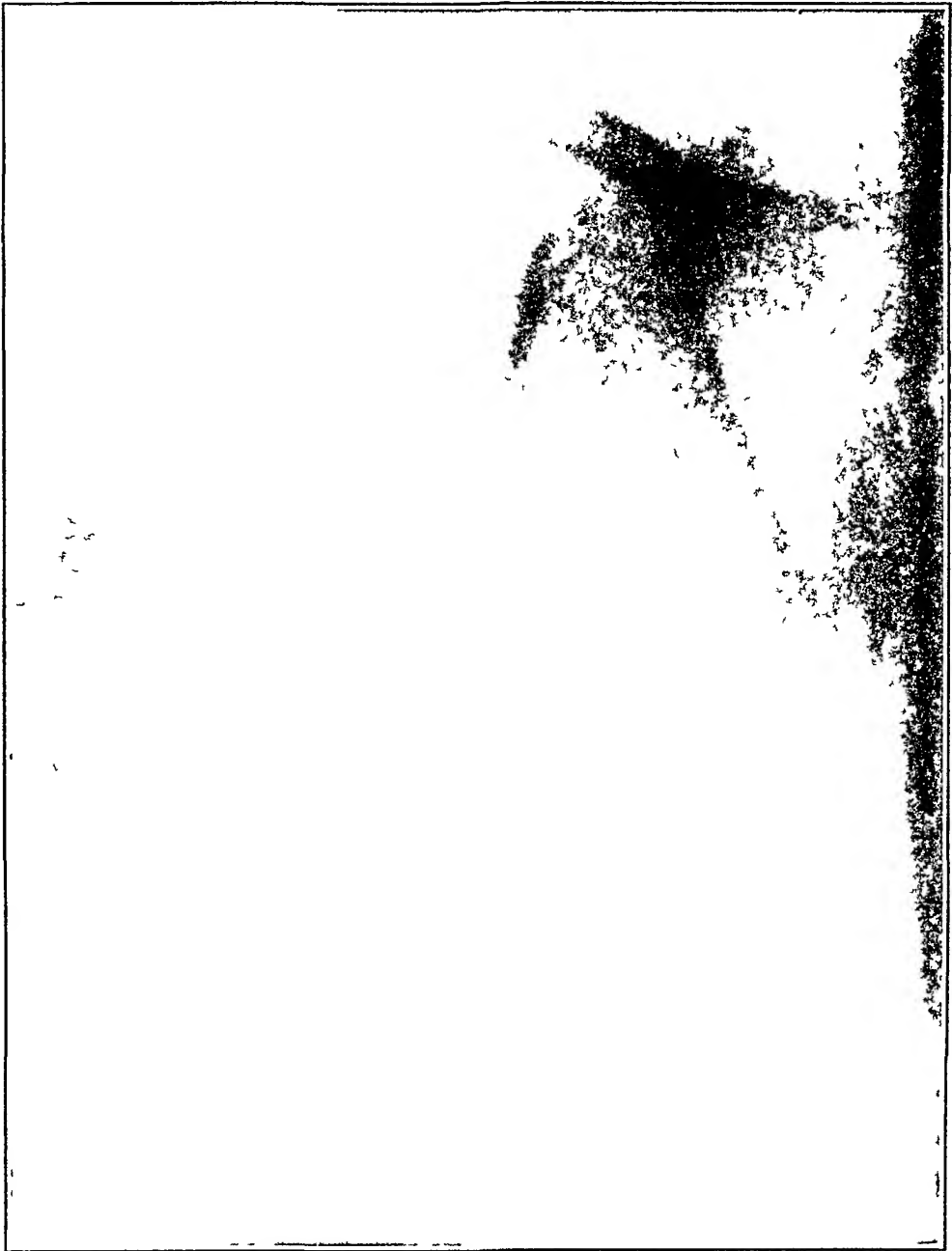


FIG 6 —Compound comminuted fracture of humerus Arm run over by freight car and bone crushed into minute fragments over width of car wheel. Attempt to suture with silver wire unsuccessful but wire caused no trouble Bone grafting refused



FIG 7—Functional result after injury shown in FIG 6 Flail joint weakens arm but patient is able to work as freight conductor



FIG 8—Illustrating importance of dealing with wounds of soft parts in case of compound fractures Patient had a bad compound comminuted fracture following kick by army mule Complete paralysis of musculospiral nerve which was caught over a small spur of bone in the callus Patient had complete voluntary extension of the wrist and fingers three months after freeing nerve

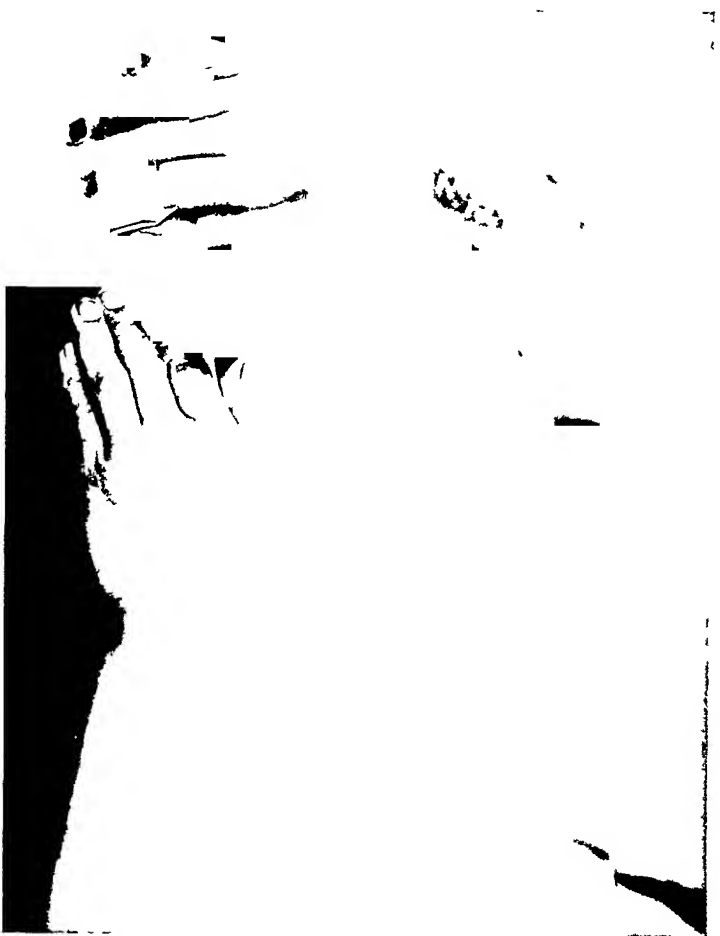


FIG 9—Gunshot injury of right forearm with extensive destruction of overlying soft parts exposing extensor tendons, one-third shaft of ulna shot away, about 7 cm of ulnar nerve destroyed. Illustration shows flaps turned from radial to ulnar side of forearm to cover exposed tendons, autogenous grafts obtained by taking two strips of skin from forearm above under local anesthesia and snipping into multiple small grafts to cover area from which flap was turned, paralysis of ulnar nerve shown by atrophy of interossei and inability to hold paper by adductors of thumb with right hand. Later at second operation ulnar nerve transplanted in front of condyle of humerus and sutured and pedicle flap from chest to supply skin and soft parts to cover bone graft of ulna, third operation. Good functional arm reported by letter two years after injury.

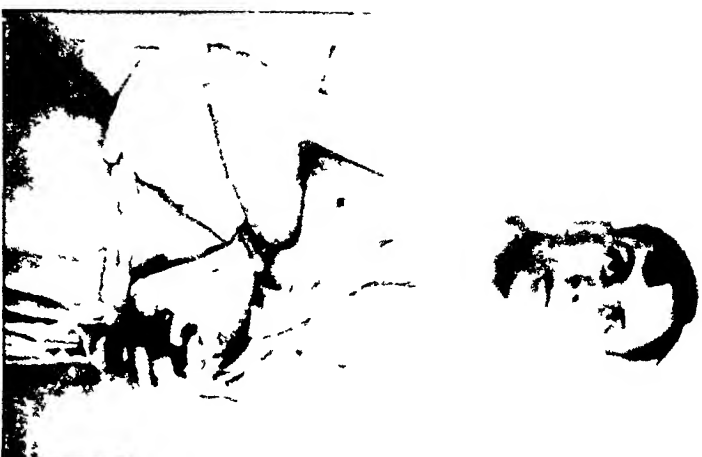


FIG 10—Pedicled flaps from chest to replace extensive destruction of soft parts of forearm. Greater comfort of patient and adequate immobilization by using binder and heavy pads or small pillows and broad adhesive straps instead of plaster-of-Paris.

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contracture tends to follow tendon suture with considerable resulting disability. Avoiding incision directly down through skin and sheath and early physiotherapy help to avoid this. Tendon-lengthening by various methods has not given me as good satisfaction as direct suture, even where joints have had to be extremely flexed in order to get apposition of the ends which had been separated for a long time. In injuries of longer standing the use of free fat transplanted under adherent tendons and covering with a pedicle flap, including a fair amount of fat, frequently give excellent results where there has been loss of function because of adhesions. This is, of course, usually avoidable if reconstructive measures can be carried out early. The value of physiotherapy immobilizing fingers and joints which have been stiffened is well enough understood not to need more than mention. The importance of tendon repair is most appreciated by persons who use their fingers and hands for highly skilled work. Among my patients have been a number of musicians, including a cellist, flutist and pianist, who were completely incapacitated from playing their instruments by reason of relatively trifling injuries involving tendons. These patients have been able to play as well as ever in a short time after the suitable measures for repair.

Peripheral Nerve Injuries are common in connection with crushing injuries, gunshot wounds and other causes of compound fracture. The importance of early reconstruction work in these injuries was another of the important lessons taught by the experience of the world war. The records of Dr E M Hummel showed that over 600 peripheral nerve injuries came under observation during nine months following August, 1918, at Ft Des Moines. Those patients who had had immediate nerve sutures at the front, in several instances, had early return of function. In other instances, partial function was recovered, and in all these cases the secondary operation was made much easier and the prospect of recovery of function greatly improved. Even in case of wounds which became infected the nerve frequently held together, making later reconstruction surgery much simpler. In over 90 per cent of the cases in which peripheral nerve operations were performed local anæsthesia was used for an hour or more of the tedious dissection which was usually required to free the nerve and its branches from scar tissue. The patients were made the judges of the efficacy of the anæsthesia, and if any complaint was made a general anæsthetic was administered at once. The large majority of the patients were entirely satisfied with local anæsthesia and the work demonstrated to many skeptical reserve officers the possibilities of local anæsthesia in difficult major surgery. Compound fractures with open wounds which came to us infected were rendered relatively bacteria-free within a short time, in many cases, by careful use of the Carrel-Dakin method, making it possible to skin-graft or turn flaps and get rapid and satisfactory healing of the wound and soft parts. Such reconstruction surgery, making possible the restoration of function to muscles and tendons whose

movements are controlled by the injured nerves, is equally as important as the repair of the injured nerve. In discussing peripheral nerve injuries elsewhere I have called attention to this important interrelation of function. In a few cases in which secondary operations were necessary, we demonstrated to our satisfaction the value of transplanted fat in preventing adhesions and pressure on tendons and nerves. In certain doubtful cases neurolysis was done, freeing the nerve from surrounding scar-tissue, and in case it was not possible to place it where readhesion was not almost certain to occur the nerve was surrounded by a fat flap. In several of these cases where function did not return within a reasonable time the injured area was excised and nerve suture done. In these cases, without exception, the transplanted fat was found in good condition and capable of serving the purpose for which it was used. If nerve function can be restored early a great deal of disability from fibrous changes in muscles can be avoided, as well as tedious freeing of contractures by the various means of physiotherapy. Of course, when contracture or stiffness has developed, the physiotherapy is of great value, but by early reconstruction surgery such disability usually can be avoided, with saving of time and frequently the difference between a relatively perfect and imperfect result. The autotransplants of Huber (nerve-grafts) have been shown by experience of several observers to give a fair percentage of successes when too much nerve was destroyed to permit of immediate suture by any method. This statement is made on the basis of personal experience and reports of other reliable observers, with all respect for the opinions to the contrary of some good neurological surgeons.

Bone The rule should be, "Save all that is possible." Army experience showed many useful extremities following infected compound fracture with comminution into almost innumerable small fragments. Carrel-Dakin treatment is of great value if impossible to clean the wound by excision without too great sacrifice. Covering exposed bone with a flap immediately or early should be done if possible, but recent experience shows considerable exposed bone may recover under Carrel-Dakin treatment and the fragments form a strong shaft. A fairly useful extremity may be obtained even if a considerable part of the shaft of the long bone is destroyed which is not replaced by bone-graft. Methods of fixation depend largely on choice of the individual, but the army type of splint is well adapted for dressing reconstruction cases. Bone-grafting gave uniformly good results in the hands of many surgeons in the war and it scarcely demands extended comment.

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SPECIAL POINTS IN THE TECHNIC OF OPERATIONS ON THE THYROID GLAND

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How Much Gland Shall Be Left? The amount of gland to be left varies according to the type of goiter. A block of hyperplastic gland (exophthalmic), half an inch square, and an inch long, would probably have as much functional value as a piece of colloid gland ten times as large, for the reason that the hyperplastic gland consists almost entirely of large columnar cells, while the colloid goiter is made up mainly of colloid material and a single layer of cubical cells. The amount to be left should in general be the functional equivalent of a normal gland. This would mean only a small portion of an exophthalmic gland, but in the case of a large colloid goiter, a bulk larger than that of a normal thyroid is required because the colloid goiter is not as active as the normal gland.

In our earlier operations we usually erred by leaving too much of the gland. It was only by trial and error that we finally realized that in cases of exophthalmic goiter a very small amount of gland is sufficient.

What Part of the Gland not to Leave In our earlier series we followed Kocher's advice and removed the larger lobe, leaving intact the smaller lobe, expecting that the readjustment of the trachea, larynx, and the smaller lobe would be satisfactory to the patient. For cosmetic reasons this proved very unsatisfactory to the average American patient and we were sometimes obliged to resect the remaining lobe. Then we resected both lobes—leaving the posterior capsule (C. H. Mayo) and only a portion of the upper and of the lower poles on each side, believing that thus the parathyroids would be well protected, and the gland well distributed. Though this was better than unilateral thyroidectomy, the poles would too often display themselves as lumps. This plan was not entirely satisfactory.

In our first series, unless it was enlarged, the *median lobe was left*. We soon found, however, that occasionally after operation this quiescent lobe increases markedly in size, giving the appearance of an Adam's apple, which in the case of women, in particular, proved unpopular. As a matter of precaution this lobe is now routinely removed.

Line of Division of the Preglandular Muscles We have dealt with the preglandular muscles in many different ways. A long vertical median incision, depending on lateral traction for exposure of the gland, was soon abandoned, except for adenomata occupying a median position or for small goiters. For laterally developed lobes, and in exophthalmic goiter, the single median division of the preglandular muscles is too often unsatisfactory.

We have tried the high division of the muscle, employed by C. H. Mayo

For the majority of cases this gives adequate exposure, but in some goiters it does not always give adequate opportunity for the dissection of the lower pole

It is for these reasons that, when more than a vertical incision is required, we have adopted the transverse division

Tying the four arteries outside the capsule occasionally results in parathyroid deficiency because of the limitation of their blood supply In about one hundred cases I made a bloodless, sharp knife separation of the true capsule from the surrounding tissues, whereby the parathyroid and the recurrent nerves were plainly exposed and were, therefore, left anatomically safe From the anatomical and dissectional point of view, this is a perfect technic, but it has one defect which condemns it—occasionally, although the voice was little or not at all disturbed for some days after the operation, a hoarseness appeared later and persisted in spite of every form of treatment This was presumably due to involvement of the recurrent nerve in the new scar tissue

Catching of masses of thyroid tissue by large forceps and then ligating them by needle and catgut *en masse* was tried as a means of minimizing the number of ligatures and cutting down the time of operation From these two standpoints, this manœuvre proved a great success, but the pulling together of such a mass of tissue occasionally interfered with the voice This method was, therefore, abandoned and the more detailed method of catching the individual branches of the main vessels with small forceps was adopted

Turning Out Gland with Finger—In our earlier series, after the gland was freely exposed, the forefinger was slipped behind or below or above it, and the deeply lying gland rolled out into view, thus greatly simplifying the operation This did well in most cases, but in the case of a *bilateral*, deeply burrowing goiter, especially if it is wedged tightly in behind the larynx to that considerable force is necessary to dislodge it, the mere traction and pressure and stretching—that is to say, the mechanical abuse of the recurrent nerves—even though they are not torn, may block the passage of nerve impulses and hence may cause an immediate bilateral paralysis of the vocal cords, which will interfere with or completely block the intake of air, necessitating an immediate tracheotomy Or, in the case of a partial paralysis, respiratory distress may occur after the operation, necessitating the reopening of the wound, even a tracheotomy The actual number of such *contretemps* may be few, but one such case seems the equivalent of many in the impression it makes, more especially if, following the tracheotomy, broncho-pneumonia and later death ensue in an otherwise sound and curable patient

There is another objection to this otherwise highly desirable manœuvre—the turning out of a large thyroid from its burrow with the finger, which applies especially to cases in which the lower pole extends into the chest In such a case everything may be progressing well, the projecting lobe is rolled out carefully, but just as the manœuvre is completed, a large vein, greatly

stretched, tears, and a full stream of venous blood fills the hole vacated by the ousted lobe. The entire field is at once stained and blood-soaked. The particular vessel is not seen. Promiscuous grasping with forceps in this black pool is a gamble. Packing the entire cavity with gauze will quickly arrest the hemorrhage, but meanwhile the mechanical process of gauze packing has torn neighboring, equally thin-walled veins, which are waiting their opportunity to bleed when the gauze is removed. Everyone gets out of this predicament in his own way, and his own way is usually different in each case. The best method is *prevention* by a controlled technic, which implies grasping every vessel in advance of its rupture and the primary separation of the upper attachment of the lobe so that the thyroid will rise spontaneously with but slight *pull* from above, not *push* from below.

' Catching and Tying Bleeding Vessels on the Surface of the Trachea — If the dissection is carried directly on the trachea or larynx, and vessels are so divided that they can be caught only by picking up and tying the peritracheal fascia with the vessel, thus including the sensory nerves which enter the wall of the trachea, the brain interprets this the same as a foreign body in the trachea. There will be irritation, coughing, increased mucus. If there is increased mucus and coughing, a local tracheitis will occasionally develop. A local tracheitis in turn will occasionally terminate in bronchitis. Bronchitis occasionally develops into broncho-pneumonia. Broncho-pneumonia may terminate in death. Thus an innocent ligature may cause death.

Contact with the trachea and the larynx may be wholly avoided by a sharp, bloodless dissection above the line of cleavage, and hence at a sufficient distance from the trachea and larynx to tie the vessels, without including the sensory nerves of the trachea, leaving on the trachea an undisturbed biologic coat. This is a most important point.

Interference with the Mechanism of Swallowing — In cases in which a growth is thrust backward on each side behind the larynx, and between it and the œsophagus and the pharynx, if the encircling portion of the gland is dislodged with the finger, in some instances there will result interference with the innervation of swallowing, and the consequent difficulty in swallowing may persist for several days. As a result fluids and even solids may enter the respiratory tract, causing paroxysms of coughing and even broncho-pneumonia. A like interference with swallowing may result when the superior thyroid artery escapes and retreats above, just as the inferior artery may retract below. The interference with swallowing is due to the physical injury of the nerves in the catch-as-catch-can process of grasping the vessel. The dissection may be led into this territory without appreciating the risk. Caution and prevention is the only safe method.

Respiratory Obstruction During Operation — With nitrous oxid oxygen apparatus, oxygen under pressure may be at once given in case of tracheal obstruction. We have seen a collapsed trachea dilated at will with a change in pressure by means of the gas-oxygen apparatus. But if for any reason

tracheotomy is needed, a transverse small opening between the rings with a knife should be made early rather than late. Just as soon as the obstruction is removed, the trachea may be closed with a French curved round needle, and the wound closed as usual. If conditions are favorable the wound may be closed.

Maintenance of a Clear Field—For every reason the field should be kept clear from the start to the finish. No division of tissue should be made through blood, especially if scissors are being used. We prefer the knife because the division is more definitive and the chance for error much less.

Blood in the Trachea—If, in an emergency, the trachea be opened the inhalation of blood must be avoided whatever may be the cost in effort and precaution. This is assured by the control of the local field by hæmostats, and by the sheer skill of the first and second assistants. Inhaled blood is very likely to cause death from broncho-pneumonia.

After all these statements regarding the possible sources of error it would seem that a thyroidectomy could not be made satisfactorily, that the possibilities of danger are innumerable, and beset the operator on all sides. But these difficulties cease to be pitfalls the moment the possibility of their occurrence and the manner of their avoidance have been fixed in the mind of the operator and in the minds of his staff. There has been no tracheotomy in our last 1080 operations. By bearing in mind the precautions indicated above we now rarely see any, even the minor, mishaps.

Delayed Closure—In any serious case the wound is left wide open—completely so, the divided muscles and tissues down to the trachea and larynx and the depths of the wound under the clavicle—and the open wound is dressed with 1-5000 flavine gauze. The advantages of this procedure are

- 1 It shortens the time of operation. It may cut off the fatal last minute.
- 2 There is practically no postoperative pain or discomfort, thus it lessens by so much the postoperative drive.
- 3 *And most important* leaving the wound open prevents the absorption of wound secretion. Aseptic wound secretion has always been known to cause some postoperative increase in temperature in normal non-sensitized individuals, but in the hypersensitized, exophthalmic goiter patients, this reaction may be multiplied many times and become a raging, destroying fever.

These wounds are closed under analgesia and local anæsthesia without removing the patient from bed, as soon as it seems safe, usually in the afternoon of the same day—sometimes the next morning—occasionally on the second day after operation.

As for infection, the wounds closed on the same day run a course almost

identical with those in which primary closure has been made. There is a slight tendency after the first six hours to increased contamination.

When to Stop the Operation—If there is any doubt of the outcome at any point, that is the moment to stop the operation, tie off the ligatures and dress the open wound with flavine. Whether mistaken or not, the operation can usually be resumed and completed on the following morning.

Deception of the Patient—Patients are not deceived as to the time of operation. If we have their consent and confidence, we go ahead so carefully, that they are not aware of the day and the hour of operation. But, if a patient demands to know the proposed day and hour, he is told. If, in consequence of this information, his condition becomes unsatisfactory, operation is deferred. This is only an occasional experience. After the strain of one delay, the patient usually is willing to take a passive rôle.

X-ray Treatment in Thyroidectomy—X-ray treatment does reduce the activity of the thyroid. It is a simple, painless procedure. Then why not use X-ray to the exclusion of other procedures? Because of the following disadvantages

(a) The dose required to produce a given effect is at best a guess

(b) Relapses are common

(c) The delay in unsuccessful cases leads to serious damage to certain organs—the myocardium, liver, nervous system, etc.

(d) In case of operation later, the scar tissue and adhesions caused by the X-ray are a handicap. The dilemma in the use of the X-ray is Myxedema or relapse. If the dose is sufficient to kill all the thyroid cells, myxedema results, if the dose does not kill the cells, they recover and there is relapse.

Indications for Ligation—In this clinic ligation is employed only as a preliminary to thyroidectomy. Double ligation rarely cures, but as is the case after X-ray treatment, there is a tendency to relapse. And when relapse occurs, we have lost the nicest step in the graded operation.

X-ray might be used instead of ligation as a part of a graded operation, excepting for the uncertainty of the extent to which it has destroyed the thyroid tissue.

To What is the Good Effect of Ligation Due?—Certainly not to the diminution of the blood supply, for no matter how soon or how late after ligation the thyroidectomy is performed the local blood supply is found to be diminished but little. In fact, it often seems as if the blood supply after ligation is richer because of all the developed collateral branches. I am of the opinion that the greater part of the benefit from ligation is the result of a break in the nerve supply of the thyroid since the principal sympathetic nerves run in the walls of the superior thyroid arteries.

What is the Indication for Thyroidectomy? *Diagnosis of Hyperthyroidism is the Indication for Thyroidectomy*—We believe this because if we wait to try out the rest cure, in that case rest fails to cure, and this is true in too

many cases, and when the rest cure fails the patient has sustained serious additional damage, perhaps permanent damage, to the myocardium, to the liver, to the nervous system, his life has been shortened, the difficulty of the operation has been increased, and much time has been lost

It is only within recent years that we have been able to put hyperthyroidism in the class with appendicitis as to operability, but now the mortality of thyroidectomy is almost as low as the mortality of appendectomy. In view of the comparatively short stay in the hospital, the slight risk, the inconsequential scar, we are prepared to accept the dictum "*operate on diagnosis*"

NOTES ON SURGERY OF THE MEDIASTINUM

BY ARNOLD SCHWYZER, M D
OF ST PAUL, MINN

SURGERY of the mediastinum comes into question in *inflammations*, especially after injury, be it from direct penetrating wounds or from perforations, mostly from the side of the œsophagus. In one such case I found an easy access and good exposure of the *posterior mediastinum* by resecting several ribs near the costovertebral articulation. The pleura could nicely, and without injury, be stripped free. In this way good access was procured. I cannot convince myself that the procedure of Heidenhain is always preferable, where one enters upon the transverse processes of the vertebræ by an incision near the midline and frees the deep musculature of the back toward the side. Heidenhain then removes the transverse processes and the corresponding portions of the ribs. In this manner the danger of injury to the pleura is thought to be more safely avoided. Surely the wound is much deeper and the orientation more difficult. Our case was a septic phlegmonous infection from a foreign body in a child. The operation did not, however, save the patient from the severe sepsis.

Purulent infections of the *anterior mediastinum* apart from direct trauma are mostly due to a breaking down of lymph-glands or to the advance of an abscess which started in the neighborhood. Of each of these two conditions I have seen one example.

One was an abscess along the pericardium on the right side. It originated from a tuberculous chondritis of the fourth, fifth and sixth ribs. It had apparently started on the under surface. The abscess formed a narrow cavity of about 4 or 5 cm depth along the pericardium. As tuberculosis of the rib cartilage never heals, if only the affected portion is removed, the whole of the affected cartilage was thoroughly excised, iodoform was rubbed into the wound, the wound was closed up to a fine silkworm drain and healing occurred promptly.

The second case was a lymph-gland abscess, taking its origin from what seemed to be one of the right peritracheo-bronchial glands. Poirier and Cuneo mention that the glands of this group, the peritracheo-bronchial glands of the right side, are the most frequently affected ones among the peritracheo-bronchial group. The abscess in our case was located behind the second and third cartilages on the right side. After resecting these we entered the abscess cavity, at the depth of which (perhaps 5 or 6 cm below the surface) a somewhat melanotic but principally chalicotic necrosed lymph-gland of the size of a peeled almond was fished out. The patient was a stone mason, which explained the chalicosis. There was little organic matter left in the gland, it consisted

principally of grayish grit. Healing after a few weeks. The case became doubly interesting when our patient returned about three years later with a similar condition on the other side. This time the abscess pointed in the sternal notch, near the head of the left clavicle, and after incision we could enter an abscess cavity downward and inward behind the manubrium sterni, again about 5 cm in depth. Again a necrotic mass came out, though only after about a week. It was a necrotic lymph-gland of the anterior mediastinum, belonging to the group which lie in the angle of division of the superior vena cava into the two innominate veins, and which Bartels (*Das Lymphgefäßsystem*) describes as *lymphoglandulæ anguli anonymi*. Healing after six or eight weeks.

Apart from purulent infections the mediastinum may be the seat of quite a variety of pathological conditions, in the detection of which the Röntgen rays are by far the most important though not exclusive agent. The most frequent occurrence is a tuberculous enlargement of the hilum glands in connection with pulmonary tuberculosis. It is important to remember that in children such large lymph-gland masses may often be primary, *i e*, without pulmonary findings and probably propagated from mesenteric tuberculosis. Occasionally tuberculosis may affect the mediastinum in the form of a cold abscess with its origin in a vertebra or the sternum. Lues in the form of gummata or massive thickening around trachea or bronchi and the large vessels is not very infrequent. History, Wassermann, and lesions in other parts of the body are of course to be taken into the reckoning. Hodgkin's disease and leukaemia can form very large masses in the mediastinum. Compared with other shadows of the same extent they give the least local symptoms, be they circulatory disturbances, tracheostenosis or difficulty at deglutition.

The *thymus* may be enlarged by simple hyperplasia or it may be the seat of neoplasms, though Hoffmann in Nothnagel's "*Specielle Pathologie und Therapie*" rightly doubts the possibility of definitely recognizing the exact origin in any advanced tumor of this area. Especially the comparatively frequent appearance of lymphosarcomata in the anterior mediastinum is thought to have its origin in the thymus, but may of course have just as well the lymph-glands of this area as matrix.

Intrathoracic goiters are among the most frequently seen tumors of the upper mediastinum. They represent a most important and interesting surgical subject, but can only be mentioned in passing.

Aneurisms are another affection of prime importance, particularly those of the different portions of the aorta and of the innominate artery. The Parisian surgeon Guinard reported good results in operation for the aneurism of the truncus anonymus by peripheral ligation, *i e*, ligation of the common carotid and the subclavian arteries near the aneurismal sac. I operated on one case in this manner and I may be permitted to report it in short. The patient had been kept flat on his back in bed for six months, and for fear

of rupture he had not even been allowed to sit up for a meal or any other function like defecation. The two arteries were ligated at the same session, and ten days after the operation our patient walked about and could go home. He is now well for over eleven years. The one important point in the operation is to ligate the carotid first and then afterward the subclavian, because embolism occurs easily at the moment of ligation of the first artery, apparently due to the suddenly increased pressure, furthermore to the sudden change in the course of the blood stream and of the whirls in the aneurismatic sac.

As a last chapter, the *neoplasms* remain for discussion. The benign ones are much rarer than the malignant tumors. A few *lipomas* are described, they seem to have started underneath the ribs, and at least two of them, I find, grew outward through an intercostal space, and were thus recognized.

The *chondromata*, a very few in number, started from the chest wall. Only their later course of growth will decide their benign or malignant character.

Of *fibromas* Hoffmann found half a dozen, some of which belong to the older literature and are inexactly reported. I shall describe further on a case of fibroma with partly rather cellular areas. Doctor Bell, Professor of Pathology of the University of Minnesota, considers the tumor however a true fibroma.

Over one hundred *dermoids* have been reported. When still small, they are mostly situated behind the sternum. They develop laterally and grow more and more into the pleural cavity, where they may reach an enormous size, even to fill practically one whole pleural space.

Among the malignant neoplasms we find carcinomata, which take their origin mostly from the oesophagus, at times from carcinoma of the breast or from the trachea or the bronchi. Sarcomas and lymphosarcomas are not so very infrequent. The sarcoma makes large nodular masses, generally prominent on one side of the mediastinum. The X-ray shadow has a rather rounded, sharp outline, which according to Sauerbruch (*Chirurgie der Brustorgane*, 1920) is mainly or exclusively seen on one side of the mediastinal shadow. This is due to a principally expansive growth. The lymphosarcomata, on the other hand, with their exquisitely infiltrating character invade and permeate the neighboring organs rather than simply displace them. The lymphosarcomata form more diffuse neoplastic masses, which show on both sides of the mediastinal shadow. Following the lymph channels they enter along the bronchi into the lung fields, where they produce a marked thickening of the shadow of the hilus with branching along the bronchi like in bronchial carcinoma. This ramification is dense and gives an almost mottled appearance. The malignant tumors of the mediastinum are operable only if unusually favorable circumstances are encountered. Burnham, of Johns Hopkins University (*Jour Am Med Association*, September 22, 1917), writes that, so far as he had been able to ascertain, there had never been a surgical

cure of a malignant mediastinal tumor I could not go through the whole literature of the subject, but found at least one successful case of a spindle-cell sarcoma reported in the *Beitraege zur klinischen Chirurgie*, 1901, p 774, operated upon by Marwedel in Czerny's clinic. The tumor was situated behind the sternum and was larger than a man's fist. It formed a sharply outlined mass which could be cleanly removed after resection of the manubrium sterni and of short pieces of the first and second ribs. At the time of the report the patient was well, two years and two months after the operation. Another case of sarcoma by the same operator and reported at the same place, had grown into the mediastinum from its primary seat in the major pectoral muscle. Death one year after the operation.

For the present our only hope in nearly all of these cases lies in the Rontgen rays and more especially in radium. Very large doses of radium with sufficient filtering to remove all but the very hardest gamma rays seem necessary, according to Burnham, who reports most remarkable results. He used only those radium rays which were left after filtering with 3 mm of lead. If the radium can be introduced into the tumor mass, smaller quantities may be sufficient.

I can report a case in this connection.

On February 21, 1917, a gentleman of twenty-six years consulted me for a mediastinal angiosarcoma. The clinical picture was typical. Our patient was cyanosed. His face was puffed up, the eyes glassy, the veins of the neck distended. Pain in the chest was complained of. A moderate but annoying dry cough existed, pulse 125, temperature $99^{\circ}/_{10}$. For many weeks the patient had not been able to sleep in bed or to lie down on account of his dyspnoea. Over the upper part of the sternal region there was a bulging, which was soft to the touch like an angioma. The diameter was about 10 cm. At the periphery you could see tortuous veins. On March 6th, after some X-ray treatment, we gave a few whiffs of ether in sitting posture, tied the peripheral blood-vessels off by interrupted circumferential sutures, made a vertical incision down to the sternum, inserted the radium (50 mg) into the wound, and immediately packed and compressed. The tendency to bleed was fearful, but compression and some clamps stopped it. The radium was left in only seven hours. Four days later without anæsthetic we made a groove into the manubrium sterni with Luer's gouge bone shears. The bleeding forced us not to go farther. The radium was put into this sternal groove and left in for twenty-three hours. After this the patient felt easier, did not cough as much as before, and began to sleep at night. On March 17th, we went through the sternum and inserted the radium into the retrosternal tumor mass. The tendency to bleed was incomparably less than previously, especially than at the first incision. This time, and one week later, and again after another two weeks, the radium was placed into the wound, each time for about forty-eight hours. In all the patient had 8600 milligram-hours. If we



FIG 1 —Röntgen plate of tumor

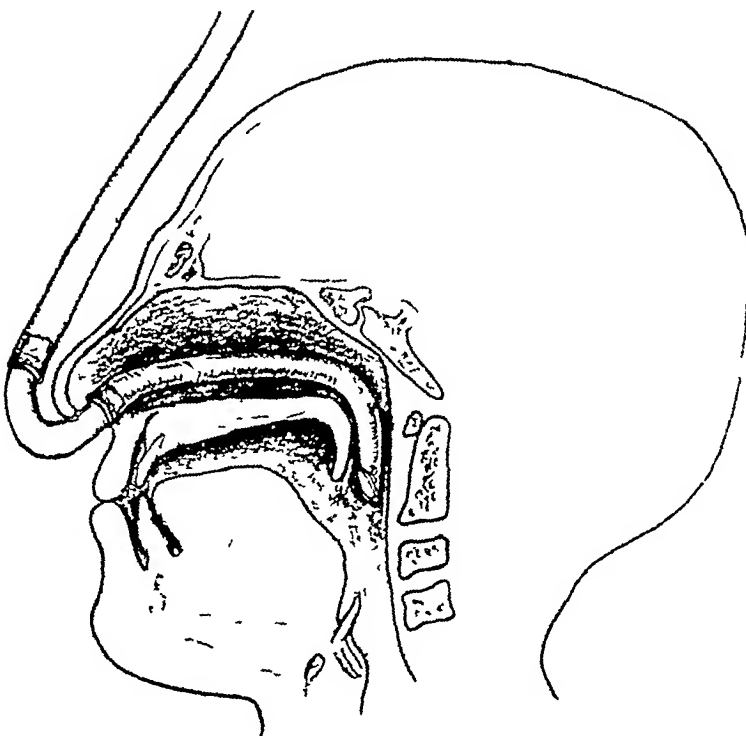


FIG 3 —Pharyngeal intubation. The nasal and the afferent outer rubber tubes are connected by a sharply bent lead tube to insure freedom and room for operator

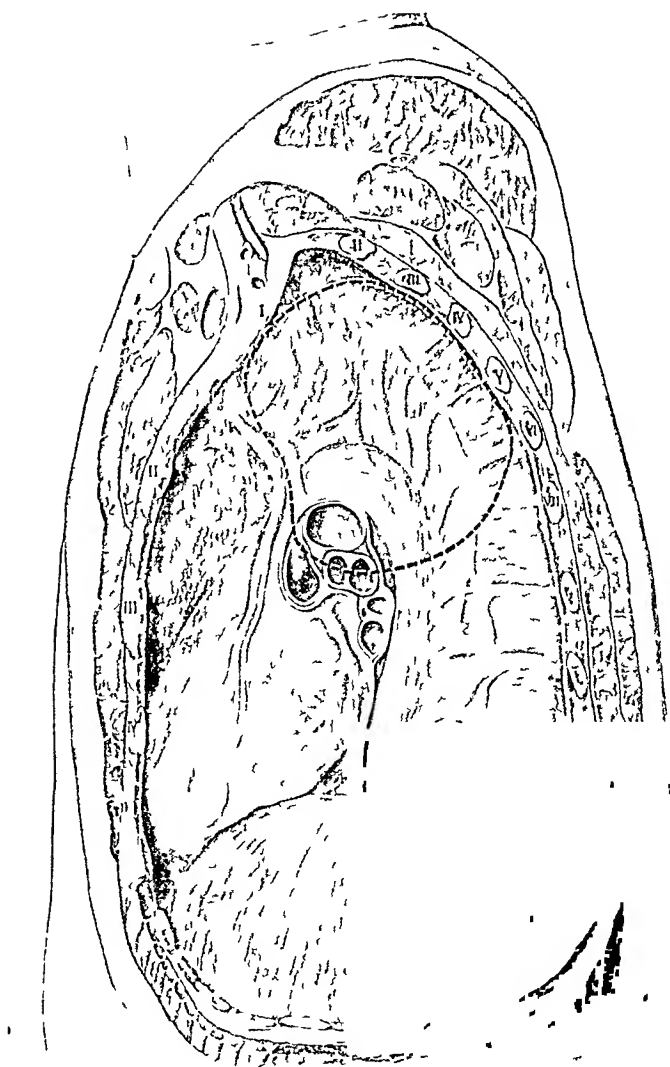


FIG 2 —Showing location of tumor dotted outline inserted plate taken from Corning's Topographic Anatomy

SURGERY OF THE MEDIASTINUM

consider that this dose was given *in* the tumor, it is a very respectable dose and more than is usually given, for instance, in a carcinoma of the uterus. In addition we gave during that time (including two pre-operative treatments) five X-ray exposures (ten to fifteen minutes, hard tube, with 3 mm aluminum filter). Pain in the left shoulder was complained of for a while, but the general condition was greatly improved. The patient could sleep in his bed, up to eight hours in the night. He went to the theatre, traveled to his home and came back during the eight weeks he was under our care, and was most enthusiastic. Three months later, I was informed that he succumbed to what was declared a pneumonia.

The principal stimulus for this paper was the following case of fibroma of the upper posterior mediastinum.

A cigarmaker of forty-three years, Russian Jew, was referred to me in December, 1919, for stomach trouble and pain in his chest. His history reads: The beginning of the present trouble dates back nine or ten years. He first noticed stinging pain in the heart area. Four or five years ago vomiting started. It only occurred at times and stopped for two years, to come on again in Spring of 1919. The pain around the heart was the same as ten years before, no worse, not all the time. He can walk well, does not get out of breath. His complaints are really quite moderate, and he had consulted his doctor for the stomach condition only. An X-ray of the chest was made on account of the stinging pain in the left side above the heart, and a tumor was found. The patient declares that since about a year ago his voice is not as strong as it was. It gives out quickly when talking. For certain reasons the patient could not take care of his condition at that time. But after pain had set in in the corresponding region on the dorsal side, and had remained constant for three months, he decided to accept the proposed operation.

The tumor was sharply outlined, did not pulsate, showed no definite growth in the four months he was under observation. By a very competent roentgenologist the mass was declared to be probably a malignant tumor and radium treatment was advised. We could not definitely decide between neoplasm and an intrathoracic struma, though the larynx seemed to move at deglutition. It was thought best to go in and see. If we should encounter an abnormally isolated intrathoracic goiter (a true struma accessoria intra-thoracica) or a well walled-off tumor, this was the only proper course to take. If, on the other hand, we had an inoperable malignant tumor, we could insert the radium into its interior, which would be of decided value.

On April 13, 1920, the operation was performed. A low collar incision was made on the neck. The sternohyoid and sternothyroid muscles were cut. The left sterno-cleido-mastoid muscle is also divided in order to get sufficient room and freedom for action. The thyroid is laid bare and found not to be connected downward. A tumor can be felt in the depth. We first try to get near it directly behind the

sternum, but soon find after recognizing the subclavian and left innominate veins, that access was not to be had, and that further advance would lead to tearing the veins. The lower part of the common carotid is then lifted forward with a retractor. The mass appears so hard, sessile and fixed to the left side of the vertebral column, that removal seems doubtful. Some tortuous veins run across its upper pole.

With the idea of possibly reaching an area of safety and line of cleavage for enucleation, or, in case removal was impossible, an access for the introduction of the radium into the centre of the growth, we bluntly penetrate its most superficial fibrous layer with dissection scissors. The region of the thoracic duct is avoided by keeping to the left of it. Positive pressure respiration, which had been prepared for, is now instituted by the aid of two intranasal tubes. The finger can then enter along the anterior surface of the tumor. After progressing about 6 cm. down on the tumor, the finger makes a rent in the pleura. Under the differential pressure the lung is sufficiently ballooned, that we can feel its soft, gently moving, free border. It becomes necessary to get more room. A vertical incision over the sternum enlarges the wound downward. With a finger inserted directly behind the sternum for the protection of the innominate vein a narrow segment of bone is removed with gouge bone shears from the middle of the sternal notch down to the upper border of the second rib. With a sharp bone hook in the head of the clavicle the gap in the sternum can be spread to 3 cm., and the parts are better accessible. After introducing two fingers with considerable force and making use of the cleft in the sternum, the lower pole is felt to be free, while the principal fixation of the tumor is found to be at its upper posterior side. A couple of artery forceps, with one branch inserted into the tumor, give a good hold on it. The fibrous outer layers of the mass are cut between the clamps. The interior proves to be yellowish, broken-down material, partly fluid and partly solid tissue. By crawling down on the tumor alternately with the two forceps and cutting between them the tumor is forced out. A promptly inserted large gauze packing stops the bleeding. Then, in order to obtain a hermetic closure of the pleural space, the cleft in the sternum is covered by a suture of the subcutaneous tissues, and the lower halves of the divided sternohyoid and sternothyroid muscles of the two sides are united in the midline. To make this suture air tight, the lower half of the divided left sternomastoid is dissected free toward its lower attachment and fastened across. The skin is closed up to three small superficial drains. The pulse was good all through the operation, and is 70 at its termination. On the day after the operation a dullness was found over the left side from the angulus speculæ down. This was probably blood and serum. It was left alone. Over the upper portions of the lung nice vesicular breathing could be heard. Recovery was prompt, the exudate cleared away rapidly, and sixteen days after the operation the patient went home. An X-ray picture taken on October 20th gives clear lung fields *

* X-ray examination in August, 1921 showed again entirely clear lung fields

SURGERY OF THE MEDIASTINUM

As to differential pressure, it can be said that it was not only helpful in procuring good and easy breathing, but that it was valuable in letting us recognize the amount of the bleeding. With a ballooned lung, which fills the pleural space, the blood shows better in the wound and keeps us informed of the bleeding at every moment and by every move. Not only is overpressure useful for these mentioned reasons, but it becomes indispensable and of prime importance when the possibility of injury to both pleural cavities exists as in operations directly behind the sternum.

Our apparatus was the simplest possible, and for that reason was not likely to fail us in functioning. A Ben Morgan ether chamber, which happened to be the readiest simple outfit at hand, was connected with a good large bellows. We might have used the nitrous oxide and oxygen bombs,

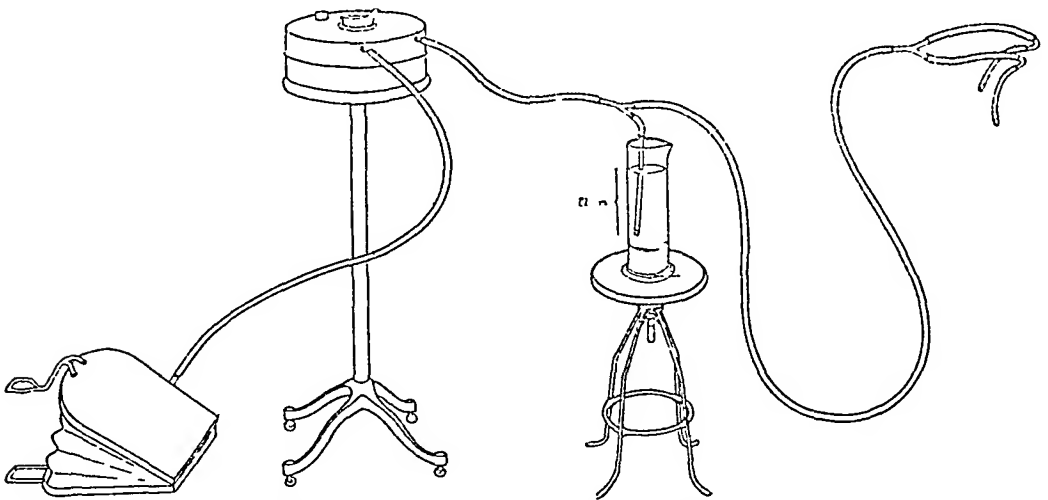


FIG 4—Overpressure apparatus for intranasal pharyngeal intubation improvised with bellows and a Ben Morgan apparatus. The glass tube, which is immersed in water, acts as manometer and safety valve.

and they were in fact on hand, but the bellows would not fail us and would not give out as a bomb will, and no disturbance and interruption by changing of bombs would have to be figured with. The ether chamber was connected by a long, good-sized rubber tube with two intranasal tubes, which are to be inserted down to—but not beyond—the soft palate. Their openings, which are cut off on a slant, are to barely show behind the velum. Between the ether chamber and the intranasal tubes, which are connected by means of a forked glass tube, the long rubber tube is tapped by a T-shaped glass piece. The third arm of it is connected with a straight glass tube, about a foot long, which reaches into a high glass vessel filled with water. This serves as manometer and as safety valve. The glass tube was so fastened in our case, that it entered 22 or 23 cm below the level of the water. This gave us approximately 17 mm of mercury pressure, a pressure somewhat too high if the mouth is kept closed tight. An assistant was instructed to work the bellows just enough to produce a gentle bubbling in the water manometer, which assured the proper pressure and let the operator hear that everything

worked well. The anæsthetist could regulate the pressure by closing the patient's mouth more or less firmly with gauze. For obtaining a gentler and more evenly sustained pressure we had formerly prepared a wide connection with a soft rubber balloon of large size, which ought to be close to the patient. As so often happens with rubber goods, the balloon, having long laid idle, was spoiled. We got along well without it, though in a long operation it would be desirable. Instead of the intranasal tubes one could use a well-fitting face mask, but the pressure would not be so even and safe. The ether chamber is not an essential. Its place can be taken by some balloon or tank like container, which steadies the pressure procured by the interrupted action of the bellows. The main tube is then tapped near the patient (as I had arranged it at a previous occasion) by a smaller tube entering from the side, through which ether vapors are pumped in according

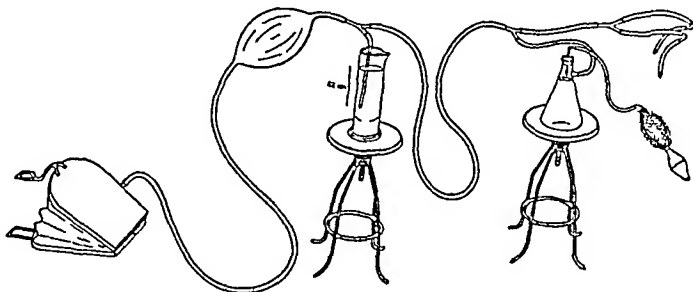


FIG 5 —Overpressure apparatus for intranasal pharyngeal intubation improvised with bellows, a large rubber bag and a small rubber bulb pump from a Paquelin cautery for the addition of ether vapors

to need by the anæsthetist.

If we do not want to introduce a stomach tube beforehand, the epigastrium needs watching for possible distention of the stomach.

What I am particularly anxious to illustrate is the point that some sort of overpressure can readily be improvised. For the occasional operator in this field it is much more important to be ready to improvise some apparatus, even if primitive, than to own a cumbersome outfit, which is stored away somewhere and may be out of order when needed. The difference in results between no apparatus and a primitive one is a good deal larger than between a primitive and an elaborate one.

In our case the differential pressure was not used long enough to produce the otherwise much dreaded shock. The narcosis was quite smooth, as is the rule in overpressure narcosis. Closure of the glottis does not occur or is at least counteracted. Vomiting is practically never seen. I can fully agree with Sauerbruch, that local anæsthesia (in its present form of development) in intrapleural operations is a capital mistake, because "forced and excited breathing, stoppage of respiration and abnormally deep aspiration with all its disturbances and shock" are then very marked.

LIFE EXPECTANCY FOLLOWING RADICAL AMPUTATION FOR CARCINOMA OF THE BREAST A CLINICAL AND PATHOLOGIC STUDY OF 218 CASES*

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THE study of these cases was undertaken for the purpose of determining, as nearly as possible, the life expectancy of patients on whom primary radical amputations of the breast have been performed for carcinoma. The factors which seem important in determining the expectancy of life were carefully studied from a clinical and a pathologic standpoint in a series of 218 patients with carcinoma of the breast operated on in the Mayo Clinic. The conclusions reached from the clinical findings and the findings at operation are discussed first, the microscopic picture of the tumors removed and the bearing which these different pictures seem to have on the prognosis are next considered.

It is impossible to foretell the duration of life of all patients with carcinoma of the breast, because the degree of malignancy varies widely, and persons react differently to the disease. For instance, certain types of carcinoma of the breast cause death within a few months after they are recognized, and other types metastasize slowly and do not prove fatal for many years, the latter, however, are rare and constitute only a small percentage of carcinomas of the breast. In the majority of these it is possible to make a fairly accurate prognosis with regard to the duration of life following operation.

It was gratifying to find, from our statistics, that the results obtained from early operations for carcinoma of the breast are probably better than those obtained in operating for any other type of malignant growths, with the exception of basal-cell epitheliomas and epitheliomas of the lip. Patients who apply for treatment may be classed in three groups.

Group 1—Patients with inoperable growths, growths firmly fixed to the chest-wall, extensive ulcerating growths with metastatic skin nodules, fixed masses in the axilla, extensive involvement of the axillary and supraclavicular glands, or internal metastasis. Operation is of no avail and is probably harmful.

Group 2—Patients who have removable growths, but in whom, because of the extent of the growth, or the glandular involvement, a cure cannot be expected by operation. Operation is often performed from an humanitarian

* Presented before the Southern Surgical Association, December, 1920

standpoint, without expectation of cure, to relieve future suffering and discomfort

Group 3—Patients with removable growths, with or without metastasis in the axillary glands These patients have a chance for cure through operation It is the prognosis in this group that we wish to discuss

By studying the results obtained in 218 cases we found that 51·8 per cent of the patients operated on, one of each two patients, were living three years after operation Seventy-five and six-tenths per cent of the patients without glandular involvement, three of each four patients, were living at the end of three years, and 36·6 per cent of the patients with glandular involvement, about one of each three patients, were alive at the end of three years (Table I)

Thirty-nine per cent of the patients, about two of each five patients, were alive at the end of five years Sixty-five and one-tenth per cent of the patients without glandular involvement, about six of each ten patients, were alive at the end of five years, and 21·9 per cent of the patients with glandular involvement, about one of each five patients, were alive at the end of five years

Thirty-six and seven-tenths per cent, of the patients, about one of each three patients, 63·9 per cent of the patients without glandular involvement, about six of each ten patients, and 18·9 per cent of the patients with glandular involvement, about one of each five patients, were living from five to eight years after operation

Of the series of 218 patients, 2·7 per cent died within six months, 21·1 per cent died within one year, 34·9 per cent died within two years, 42·2 per cent died within three years, 49·1 per cent died within four years, and 55 per cent died within five years Only 2·3 per cent died after five years Four and one-tenth per cent of the patients living from five to eight years after operation have recurrences, and it is probable that these will die from cancer After eight years the disease rarely recurs

Carcinomas which developed during pregnancy and during the lactating period invariably proved fatal within five years after operation Diffuse carcinomas which involved practically the entire breast caused death in every instance within five years, all but one of the sixteen patients with this type of growth died within three years after operation When the axillary glands were involved, carcinomas around the nipple proved fatal in seventeen of eighteen patients (94·5 per cent) within five years Seventeen of twenty patients with ulcerating carcinomas (85 per cent) were dead at the end of seven years, fourteen died within five years after operation

Age seems to have a definite bearing on the results to be expected following operation Forty-one and seven-tenths per cent of the patients over fifty are alive from five to eight years after operation, while only 31·8 per cent of those under fifty have lived a corresponding time The immediate hospital mortality was less than 0·5 per cent

LIFE EXPECTANCY BREAST OPERATIONS

In our experience the prognosis has not been affected by the complete removal of small growths for microscopic diagnosis before the radical operation is performed. When local recurrences were found following operation, metastasis was demonstrated in other regions in 60.9 per cent of the cases, or in six of each ten patients. Nearly all patients who had recurrences following operation died from the disease.

RESULTS OBTAINED IN 218 CASES IN WHICH OPERATION WAS PERFORMED

Of eighty-six patients (39.5 per cent) without glandular involvement, fifty-five (63.9 per cent) are alive from five to eight years after operation. Six of the patients had recurrences. Thirty-one (36.1 per cent) are dead.

Of 132 patients (60.5 per cent) with glandular involvement twenty-five (18.9 per cent) are alive from five to eight years after operation, three had recurrences, and 107 (81.1 per cent) are dead.

TABLE I
*Three, Five, and Eight Year Cures (218 Cases) **

Decades		Pa- tients	Alive three years after operation	Alive five years after operation	Alive from five to eight years after operation
20 to 30	With glandular involvement	3	0	0	0
	Without glandular involvement	1	1	1	1
30 to 40	With glandular involvement	16	4	1	1
	Without glandular involvement	15	11	9	9
40 to 50	With glandular involvement	50	17	10	8
	Without glandular involvement	25	20	16	16
50 to 60	With glandular involvement	28	10	8	8
	Without glandular involvement	31	24	22	22
60 to 70	With glandular involvement	26	12	8	6
	Without glandular involvement	11	7	6	5
70 to 80	With glandular involvement	9	5	2	2
	Without glandular involvement	3	2	2	2
			113(51.8%)	85(39%)	80(36.7%)
Total	With glandular involvement	132	48(36.6%)	29(21.9%)	25(18.9%)
	Without glandular involvement	86	65(75.6%)	56(65.1%)	55(63.9%)

* In thirteen cases the exact date of death was unknown.

PERCENTAGE OF DEATHS OF PATIENTS UNDER AND OVER FIFTY, WITH AND WITHOUT GLANDULAR INVOLVEMENT

One hundred ten (50.5 per cent) of the patients operated on were under fifty, sixty-nine (62.7 per cent) had glandular involvement, and nine (13.0 per cent) are alive from five to eight years after operation. Forty-one (37.3 per cent) were without glandular involvement, and twenty-six (63.4 per cent) are alive from five to eight years after operation.

One hundred eight (49.5 per cent) were over fifty, sixty-three (58.3 per cent) had glandular involvement, and sixteen (25.4 per cent) are alive from five to eight years after operation. Forty-five (41.7 per cent) were without glandular involvement and twenty-nine (64.4 per cent) are alive from five to eight years after operation.

PATHOLOGIC FACTORS IN THE LONGEVITY IN CANCER OF THE BREAST

One of the most important questions involved in the entire subject of cancer is Why do some patients live longer than others with grossly the same or even less local or general cancer? This question was emphasized in the study of a series of cases of gastric cancer,¹ in which it was found that patients with complete involvement of regional lymphatic glands often lived much longer than patients without regional glandular involvement, although as a general rule postoperative longevity is in inverse relation to the amount of glandular involvement. In one series of gastric cancers it was observed that two factors, cellular differentiation and lymphocytic infiltration, apparently play a part in the defensive mechanism against new growths. Thus patients without glandular involvement and with local lymphocytic infiltration lived, on an average, 124 per cent longer postoperatively than patients without glandular involvement and without local lymphocytic infiltration, and patients with glandular and with local lymphocytic infiltration lived 146 per cent longer than patients with glandular involvement without lymphocytic infiltration. The average length of postoperative life was increased 7.5 per cent in the presence of cellular differentiation. When differentiation and lymphocytic infiltration were both present the average length of postoperative life was increased 82 per cent. These data represent averages and do not apply to all specific cases. As general facts, they give some clue to the defensive mechanism of the body against malignant neoplasms.

In the series of 218 cases of mammary cancer here reported it was found that death had occurred in 138. In ninety-one* of these cases complete pathologic material was preserved and studied in detail from the standpoints of cellular differentiation, lymphocytic reaction, fibrosis, and hyalinization (Tables II, III, IV, and V), the two latter possible defensive factors are in greater evidence in mammary cancer than in gastric cancer.

It will be remembered that neoplasia in the breast manifests itself in three reactions—primary, secondary, and tertiary cytoplasia,^{2, 3}—and that these stages are found with or without the presence of partial cellular differentiation, lymphocytic reaction, fibrosis, and hyalinization, the last three of which, we believe, represent either etiologic factors or a defensive mechanism. The conception that the presence of cellular differentiation is unfavorable to the continued growth of cancer cells is based on the unwritten law in general biology that power of cellular reproduction is inversely proportional to cellular differentiation. If this law is correct, cancer cells which show partial differentiation, as in 15 per cent of the cases of mammary cancer studied, must of necessity grow less rapidly than cancer cells without differentiation.

The following generalizations may be made from the data studied con-

* All pathologic specimens were studied independently of any knowledge of the clinical histories or postoperative mortality. It was not until the pathologic observations were made and recorded that they were assembled with the preoperative and postoperative histories.

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TABLE II
Patients without Glandular Involvement at Operation who died

	Postoperative life											
	30 to 40			40 to 50			Decades 50 to 60			60 to 70		
	2			5			Patients 7			3		
	Years	Months	Days	Years	Months	Days	Years	Months	Days	Years	Months	Days
Longest	4	5	2	5	5	16	4	5	0	3	9	20
Shortest	3	0	22	1	2	14	1	1	16	1	8	22
Average	3	5	19	3	4	9	2	3	11	7	23	23
Average with local lymphocytic infiltration alone												
Average with local lymphocytic infiltration, hyalinization and fibrosis	3	5	19	1	3	2	1	1	16			
Average without local lymphocytic infiltration, hyalinization and fibrosis												
Average with cellular differentiation				3	4	9	2	3	11	2	5	19
Average without cellular differentiation				4	5	10	2	3	16	2	9	6
Average with local fibrosis	3	5	19	2	1	7	2	2	4	7	23	19
Average without local fibrosis				4	1	13	2	2	16	2	7	23
Average with local lymphocytic infiltration	3	5	19	3	6	5	1	5	6	5	5	19
Average without local lymphocytic infiltration				3	5	16	3	5	6	5	8	28
Average with local lymphocytic infiltration and fibrosis	3	5	19	1	3	2	3	1	6	2	7	23
Average without local lymphocytic infiltration and fibrosis				5	5	16	1	5	6	2	8	28
Average with local lymphocytic infiltration and hyalinization	3	5	19	1	3	2	3	5	6	2	8	28
Average without local lymphocytic infiltration and hyalinization				4	5	10	2	2	12	2	5	19

TABLE III
Patients with Glandular Involvement at Operation who died

	Decades					Total
	20-30	30-40	40-50	50-60	60-70	70-80
Cases						
Without cellular differentiation	3(100%)	9(90%)	28(90%)	12(92%)	14(100%)	2(66 66%)
Without local lymphocytic infiltration	1(33 33%)	2(20%)	10(32%)	4(30%)	7(50%)	1(33 33%)
Without local hyalinization	2(66 66%)	6(60%)	17(54%)	5(37%)	6(42%)	0
Without local fibrosis	2(66 66%)	3(30%)	9(29%)	3(23%)	6(42%)	0
With local lymphocytic infiltration and local fibrosis	1(33 33%)	6(60%)	14(45%)	7(53%)	3(21%)	2(66 66%)
With local lymphocytic infiltration and local hyalinization						
With local hyalinization and fibrosis	1(33 33%)	4(40%)	8(25%)	5(37%)	2(14%)	2(66 66%)
With local lymphocytic infiltration, hyalinization and fibrosis	1(33 33%)	4(40%)	14(45%)	8(60%)	7(50%)	3(100%)
	1(33 33%)	4(40%)	8(25%)	5(37%)	2(14%)	2(66 66%)
<i>Patients who Died and who were without Glandular Involvement at the time of Operation</i>						
Without cellular differentiation	2(100%)	5(100%)	0	2(66 66%)		9(52%)
Without local lymphocytic infiltration	0	2(40%)	6(85%)	2(66 66%)		10(58%)
Without local hyalinization	0	2(40%)	3(42%)	1(33 33%)		6(35%)
Without local fibrosis	0	2(40%)	2(28%)	0		4(23%)
With local lymphocytic infiltration and local fibrosis	2(100%)	1(20%)	1(14%)	1(33 33%)		5(29%)
With local lymphocytic infiltration and local hyalinization						
With local hyalinization and fibrosis	2(100%)	1(20%)	1(14%)	0		4(23%)
With local lymphocytic infiltration, hyalinization, and fibrosis	2(100%)	3(60%)	4(56%)	2(66 66%)		11(64%)
	2(100%)	1(20%)	1(14%)	0		4(23%)
<i>Total Number of Patients Dead</i>						
Without cellular differentiation						77(84%)
Without local lymphocytic infiltration						35(38%)
Without local hyalinization						42(46%)
Without local fibrosis						27(29%)
With local lymphocytic infiltration and local fibrosis						38(41%)
With local lymphocytic infiltration and local hyalinization						26(28%)
With local hyalinization and fibrosis						48(52%)
With local lymphocytic infiltration, hyalinization, and fibrosis						26(28%)

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TABLE IV
Patients with Glandular Involvement at Operation who died

	Decades												Total										
	20 to 30			30 to 40			40 to 50			50 to 60				60 to 70			70 to 80						
	3			10			31			Patients 13				14			3			74			
Postoperative life																							
	Years	Months	Days	Years	Months	Days	Years	Months	Days	Years	Months	Days	Years	Months	Days	Years	Months	Days					
Longest	3	1	10	4	9	3	7	0	3	5	7	0	4	8	4	7	0	3	3				
Shortest	0	7	0	0	5	18	0	4	6	5	13	2	8	5	7	0	3	5	5				
Average	1	6	21	2	3	16	2	4	14	1	3	13	2	3	9	0	5	17	11				
Average with local lymphocytic infiltration	3	1	0				1		15	1	8	2	4	8	3	1	2	4	11				
Average with local lymphocytic infiltration, hyalinization, and fibrosis	1	0	4	1	5	4	3	3	17	2	3	12	1	3	25	2	5	5	11				
Average without local lymphocytic infiltration, hyalinization, and fibrosis	1	7	0	1	5	2	1	5	11	0	3	14	2	8	5	1	5	18	12				
Average with cellular differentiation				3	0	0	3	5	20	4	4	27	3	2	25	4	3	5	15				
Average without cellular differentiation	1	6	21	3	7	11	1	3	8	4	3	12	2	10	4	4	5	15	8				
Average with local fibrosis	1	0	4	1	10	3	2	4	10	1	1	12	2	13	7	2	3	7	18				
Average without local fibrosis	1	7	0	2	5	5	2	4	16	1	5	6	2	15	2	8	5	13	9				
Average with local lymphocytic infiltration	2	0	17	1	7	8	2	4	12	1	4	13	2	4	5	2	6	9	12				
Average without local lymphocytic infiltration	0	7	0	2	5	10	2	4	14	1	4	13	1	3	21	2	5	12	12				
Average with local lymphocytic infiltration and fibrosis	1	0	4	2	7	14	2	5	14	1	2	13	3	3	29	2	6	12	16				
Average without local lymphocytic infiltration and fibrosis	1	7	0	1	9	8	3	3	17	2	3	12	1	3	25	2	5	16	15				
Average with local lymphocytic infiltration and hyalinization	1	0	4	1	9	16	3	5	11	0	3	14	3	2	25	2	6	15	12				
Average without local lymphocytic infiltration and hyalinization	1	7	0	2	9	16	1	5	16	2	3	14	4	2	25	2	6	12	11				
Average with hyalinization	1	0	4	1	9	16	2	5	16	3	3	14	4	2	25	2	6	12	11				
Average without hyalinization	1	7	0	2	9	16	3	5	16	2	3	14	4	2	25	2	6	11	11				

cerning ninety-one patients who died in the series of 218 patients with mammary cancers

- 1 Cellular differentiation occurred in 86 per cent
- 2 Local lymphocytic infiltration occurred in 62 per cent
- 3 Local hyalinization occurred in 54 per cent
- 4 Local fibrosis occurred in 71 per cent
- 5 Lymphocytic infiltration and fibrosis occurred in 41 per cent
- 6 Lymphocytic infiltration and hyalinization occurred in 28 per cent
- 7 Hyalinization and fibrosis occurred in 52 per cent
- 8 Lymphocytic infiltration, hyalinization, and fibrosis occurred in 28 per cent
- 9 The average length of postoperative life of patients with local lymphocytic infiltration alone was 28 per cent greater than the average length of postoperative life of the ninety-one patients
- 10 The average length of postoperative life of patients without local lymphocytic infiltration was 15 per cent less than the average length of postoperative life of patients with local lymphocytic infiltration

TABLE V
Postoperative Life of Patients Dead (Ninety-one)

	Years	Months	Days
Longest	7	0	3
Shortest	0	3	5
Average	1	8	24
Average with local lymphocytic infiltration alone	2	2	16
Average with local lymphocytic infiltration, hyalinization, and fibrosis	2	4	17
Average without local lymphocytic infiltration, hyalinization, and fibrosis	1	4	17
Average with cellular differentiation	2	8	18
Average without cellular differentiation	1	8	22
Average with local fibrosis	1	10	13
Average without local fibrosis	1	3	20
Average with local lymphocytic infiltration	1	7	22
Average without local lymphocytic infiltration	1	10	20
Average with local lymphocytic infiltration and fibrosis	1	8	23
Average without local lymphocytic infiltration and fibrosis	1	8	21
Average with local lymphocytic infiltration and hyalinization	2	4	19
Average without local lymphocytic infiltration and hyalinization	1	8	20
Average with local hyalinization	1	10	14
Average without local hyalinization	1	6	21

11 The average length of postoperative life of the patients with lymphocytic infiltration, hyalinization, and fibrosis was 37.8 per cent greater than the average length of postoperative life of the ninety-one patients as a group

12 The average length of postoperative life of patients without lymphocytic infiltration, hyalinization, and fibrosis was 42 per cent less than the average length of postoperative life of patients with lymphocytic infiltration, hyalinization, and fibrosis

13 The average length of postoperative life of the patients with cellular

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differentiation was 57 per cent greater than the average length of postoperative life of the ninety-one patients

14 The average length of postoperative life of patients with fibrosis was 7 per cent greater than the average length of postoperative life of the ninety-one patients, and 42 per cent greater than that of the patients without fibrosis

15 The average length of postoperative life of patients with lymphocytic infiltration and hyalinization was 44 per cent greater than the average length of postoperative life of the ninety-one patients

16 The average length of postoperative life of patients with fibrosis and hyalinization was 148 per cent greater than the average length of postoperative life of the ninety-one patients, and 487 per cent greater than the average length of postoperative life of patients without fibrosis and hyalinization

CONCLUSIONS

1 The three greatest single factors in increased postoperative longevity of the ninety-one patients with mammary cancers are cellular differentiation, hyalinization, and fibrosis

2 Lymphocytic infiltration alone does not appear to be the main factor.

3 It appears that while hyalinization and fibrosis play, individually, some part in increasing longevity in cases of cancer of the breast the two greatest known combined factors are cellular differentiation and hyalinization

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THE TRANSVERSE ABDOMINAL INCISION

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WITH the exception of colostomy and gastrostomy, all intra-abdominal operative procedures are of comparatively recent date, but, in spite of that fact, the literature on abdominal surgery is probably more voluminous than in any other branch of surgery

From the "anæsthesia" point of view, the work of Simpson and Morton made major surgery possible, but it remained for Lister to make the surgery of the body cavities not only possible but safe

One of the greatest living surgeons and pioneer of abdominal work said that it was almost criminal to cut any of the muscles of the abdominal wall, and therefore all abdominal incisions were planned so that they ran in the plane of the muscle fibres, allowing of their separation, and so that the interior of the abdomen, with its contents, could be explored This was held, by the majority of the surgeons, as an accepted fact for many a long day, and it remained for Maylard to give us the transverse incision, which, in many instances, has rendered intra-abdominal manipulations, which were previously regarded as some of the most difficult, the easiest operations in surgery

The history of the evolution of the transverse incision is interesting It is not certain as to who was the first to practice the transverse incision of the abdominal wall, Bardenheuer is given the credit by some

In 1896, Kustener made a transverse incision of the skin for the performance of a certain gynæcological operation, and at the time, but unknown to Kustener, Rafain, another gynæcologist, had elaborated the same technic

In 1900, Stimson reports having made use of a combined longitudinal and transverse abdominal incision, and, also in 1900, Pfannenstiel independently introduced a transverse incision through skin and fascia, in gynæcological work, which he called the suprasymphyseal transverse fascial incision

Naudet, working in the clinic of Professor Hartmann, of Paris, published results of the use of a transverse incision through skin and fascia

But the real transverse incision through the complete thickness of the abdominal parietes, and in any part of the abdominal wall, was introduced by Maylard, of Glasgow, in 1898

The history of what led to Maylard's introduction of this technic begins with the observations made by him, in his treatment of a gastric case He had operated upon a man's stomach by the ordinary median longitudinal supra-umbilical incision, but, a few days later, it was found to be necessary to reopen the abdomen, and in view of what was found, more room for the performance of the intra-abdominal operations was found to be necessary, the

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right rectus abdominis was therefore cut across. As a result, it was found that the union of the transverse part of the incision was excellent, but a post-operative ventral hernia developed in the longitudinal part of the scar.

After this result, and following upon the observations made in a comparison between the longitudinal and the transverse incisions, Maylard, a few years later, came ultimately to adopt the "transverse incision" of the abdominal wall, as a routine method for all intra-abdominal operations.

Moschcowitz, in the *ANNALS OF SURGERY*, September, 1916, part 265, says that at the date of writing the paper he had examined all his cases, and had not found one single case of ventral hernia. It is to be noted that Moschcowitz did not make his first transverse incision until August 2, 1910, or twelve years later than Maylard.

In the *ANNALS OF SURGERY*, February, 1918, part 302, J. W. Churchman describes a new incision for exploration of the lower abdomen, this incision is in the form of a Y, but according to the author is not applicable generally, but only to the pelvic branch of abdominal surgery.

After this brief résumé of the history of the transverse incision, I will now deal with the subject under various headings.

ESSENTIALS OF AN ABDOMINAL INCISION

1 It should be so planned that the maximum amount of intra-abdominal freedom is obtained, with the minimum amount of damage to nerves and muscular tissue.

2 The incision should be in such a position, and of such dimensions, that the use of retractors is reduced to a minimum.

3 It should be such that complete temporary muscular relaxation is obtained, because then retraction becomes unnecessary, and shock will be less, since the stimulus necessary for the production of the abdomino-visceral reflex, the connecting link between the abdominal wall and the intra-abdominal organs, is absent.

4 The shock should be as little as possible, with therefore less liability to primary and reactionary hemorrhage.

5 The margins of the incision should tend to fall together.

6 It should be capable of closure, without strain being put upon the constituent parts of its margin.

7 When suturing is complete the margins should be in such a position that the various tissue elements are placed directly opposite each other, so that any exertion on the part of the patient tends to bring them closer together and not further apart.

8 The amount of scar tissue produced should be as small in quantity as possible, and so placed that while it acts as a connection between the severed ends of the various tissues, it should have at no time any mechanical or supporting function required of it.

9 The amount of severance of, or injury to, nerves should be as little as

possible, so that the abdomino-visceral arcs be left proportionately intact, with little resulting muscular paralysis

Anatomically, the abdominal wall is composed chiefly of several layers of long, flat muscles—three laterally and two median. These, together with the skin, fascia, subperitoneal tissue, and the peritoneum, form the abdominal wall

There is nothing peculiar in regard to the muscles forming the abdominal wall, but the recti and their respective sheaths. These muscles are peculiar, in that they are formed of two distinct sets of fibres, one set forming, approximately, one-third of the total mass of muscle, which stretches without interruption from its origin to insertion and therefore its actions are, as far as that portion of the muscle is concerned, between these two points, the remaining two-thirds of the muscle, however, show three, sometimes four, fibrous intersections—the lineæ transversæ. These lineæ transversæ are firm fibrous bands, intimately associated with and adherent to the posterior surface of the anterior wall of the sheath of the rectus abdominis. Their function is most probably to provide intermediate points for force and resistance to allow of the recti performing what is called segmental action. By this means it is possible to increase or diminish the abdominal tensions, in any or all of the upper, middle, or lower divisions of the abdomen. This has a very important bearing upon the transverse incision of the rectus and its sheath, and the other abdominal muscles, because the result of such an incision is simply the formation of another linea transversa.

The mode of formation of the rectus sheath is well known, and it is well to remember that its contents are the superior and deep epigastric vessels, with their branches and tributaries, so that to secure efficient hæmostasis, two sets of ligatures, one pair on each side, will be at least required.

Accepting the fact that, when the nerve supply to any muscle is damaged or destroyed, that muscle atrophies to a greater or lesser extent, it is most important that all abdominal operations that require interference with muscles should have their incision so planned, that there will be the least possible interference with the nerve supply of those muscles.

The nerve supply of the abdominal muscles is derived from the seventh, eighth, ninth, tenth and eleventh intercostal nerves, the subcostal nerve, the inguinal, and the hypogastric branches of the ilio-hypogastric nerve.

The course of these nerves, from their origin to their distribution, is such that, while not transverse, it is only very slightly oblique. They run forward and inward, between the muscle planes, and perforate the posterior wall of the sheath of the rectus at its outer border, and then the anterior wall of the rectal sheath, in its outer part, prior to becoming cutaneous.

It is thus seen that from an anatomical point of view any incision made vertically, and parallel to the middle line of the body, must, according to its length, cut one or more of these nerves completely, the amount of nerve injury involved in the longitudinal incision is great, with the transverse incision the risk of damaging to any great extent the nerves supplying the musculature

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of the abdominal wall is small, the incision is running practically with them in their course, and for that reason the incision is anatomically correct

Physiologically, the action of the abdominal muscle is well known, and does not merit further discussion, except in that it is more than probable that its function of maintaining the abdominal contents in position is much overestimated

It is, and has been, held that if a muscle of the abdominal wall is injured or cut a ventral hernia will be produced, such in many instances is not the case. Every now and again one sees, after a longitudinal incision has been made in the sheath of the rectus muscle, and the patient unexpectedly strains, that the rectus bulges into the wound, showing how little real power it possesses of maintaining the contour of the abdominal wall, or of retaining the intra-abdominal contents in their various positions

Now and again, while working through a longitudinal incision, and should the patient be allowed to come partially out of the anæsthetic, it is noticed that the muscles tend to separate and not to come together, with the result that the opening in the abdominal wall is markedly enlarged, and the intestines are protruded. If, however, the incision be a transverse one, it is observed that the margins of the wound, under like circumstances, come together and prevent the escape of the abdominal contents. This is easily understood when it is remembered that a muscle acts from origin to insertion, and in the long axis of its fibres

The real factors, in the maintenance of the integrity of the abdominal wall and the position of the intra-abdominal contents, are the fascial sheaths

The *histology* of fascia is also well known and agreed upon, doubtless also are its nourishing, limiting, and protecting powers, but it has not generally received adequate amount of recognition for the invaluable function it performs, in maintaining the integrity of the abdominal wall and retaining the abdominal contents in the abdominal cavity

One naturally concludes, from experience of other such similar structures in various parts of the body that have a not too liberal blood supply, that its regenerative powers, owing to its poor blood supply would be relatively weak, but such, curiously, is not the case. Not only does it heal with great rapidity after it has been incised, but the union in the majority of cases is extremely firm, and this is probably due to the fact that it is composed of tissue elements which are not highly differentiated in structure

Sound and firm union is, in the large majority of cases, further proved, when one has to reopen an abdomen after a transverse incision has been used, when it is almost invariably found that all that remains is a narrow firm line of strong fibrous tissue, uniting the cut ends of the muscle

Pathologically, the remarkable healing properties of the abdominal fasciæ and sheaths, after being transversely incised, are probably explained as follows. All wounds heal by means of tissue which is reproduced from preëxisting mesoblastic tissue, in an aseptic wound a minimum amount of it is produced, but in a wound in which from any cause the healing process is delayed a

maximum amount of it is produced Granulation tissue in large amount is not desirable, because its elastic properties are deficient and of poor quality Any of the many factors that delay the healing process in wounds, if present, will cause a large amount of it to be produced, and the presence of blood-clot is probably the most common, due to incomplete hæmostasis at the time of operation Blood-clot is a foreign body, and has no powers of regeneration or support, it simply keeps apart the edges of the wound and delays the healing process

What is necessary is not the presence of blood-clot in the wound, but a plentiful supply of blood-vessels in the immediate vicinity, from which new vessels can be produced at the same time as regeneration is progressing in the other tissue elements of the incision

The course of the blood-vessels is at right angles to the incision, and budding is said to take place more rapidly when a vessel is cut at right angles to its long axis than when partially torn or cut obliquely along with several of its branches, if it is cut straight across, there is no damage done to its branches, which are left unimpaired and ready to form a collateral circulation

Therefore, the more perfect the mechanical closure of the wound in regard to the coaptation of the surfaces of the cut tissues, the more perfect will be the healing process

It often happens, however, that no matter how careful one may have been in this suturing, a dead space develops, in which serum, etc., gathers, keeping the cut surfaces apart, and delays or prevents the permanent closure of the wound This is now and again seen with the longitudinal incision, but practically never where the transverse incision has been used The reason is that should the suturing in the transverse incision give way, the natural tendency for the edges of any transversely placed abdominal wound is to come together and not to separate Further proof of this statement is found in the consideration of the normal physiological action of these muscles, and this is the flexion of the thorax upon the pelvis

Site of Incision—This depends upon the object of the operation In the case of an exploratory laparotomy, one, just immediately above or below the umbilicus, has been found to afford comparatively easy access to all parts of the abdominal cavity

In the majority of cases the operation is one of selection, and then, for purposes of description, one may divide the abdominals into two groups—the supra- and infra-umbilical incisions, or into three, the supra-, infra-, and trans-umbilical, with excision of the umbilicus

These incisions vary in size, according to the nature and extent of the operation, their average length is about four inches, but this is sometimes considerably exceeded

Preparation of the Patient—There are many methods of preparation in use, but that usually adopted by the writer, except in emergencies, is as follows

If possible, get the patient into hospital two days prior to operation, and

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put on a low diet Have the bowels thoroughly well "moved" The diet is gradually curtailed, so that for the twelve hours prior to the operation nothing but fluids is given It is found that when two or three days' preparation has been made, the post-operative convalescence is much more rapid

The patient upon admission is bathed, after which the skin is washed with sterile soap and water, thoroughly dried, and then washed with spirit Turpentine is then used to dissolve out the fatty matters in the skin, and thoroughly dried off A piece of white lint soaked in a one-to-forty carbolic acid solution is then applied to the part, and changed every twelve hours, the last change being two hours before operation, when a one-to-twenty carbolic compress is applied, and not removed until the patient is on the table Immediately before the incision is made, the part is thoroughly washed with spirit

In an emergency case the skin is prepared as before, but acetone is used in place of the spirit, and the part then swabbed with a five per cent alcoholic solution of iodine

Iodine is objected to by many surgeons on the ground that some of the viscera are almost bound to come into contact with it, and, as a result of its action on peritoneal surfaces, post-operative abdominal adhesions are said to be more frequent than after many of the other forms of preparation

Method of Incising—The skin is firmly fixed between the first and second fingers, and a clean cut made through skin and subcutaneous tissue down to the muscle sheath This is next incised and the muscle cut through All bleeding points are now secured and the peritoneum opened It is most important that a complete hæmostasis should be obtained The round ligament of the liver is clamped between pressure forceps and then cut through, it is sutured separately After the peritoneum is opened all bleeding points are ligatured As a rule, four ligatures only are required, two on each side, for the superior or deep epigastrics, according to the part incised And, as a rule, ligatures are not required for vessels in the subcutaneous tissues, pressure forceps being left on them until the peritoneum is opened, these are then removed, the pressure being usually found sufficient to produce complete hæmostasis

Mr Maylard has always objected to the spending of too much time in the ligation of every bleeding point, believing that in so doing there would be too much capillary occlusion, and the edges of the wound, after coaptation, would fail to be rapidly and freely supplied with blood

Method of Closure—Upon completion of the operation the peritoneum is grasped at either extremity of the incision, and on either side at its centre, by handled artery forceps These are used in preference to pressure forceps because they exert no pressure upon the part grasped, and small areas of post-operative necrosis are thus less likely to occur

In closing the peritoneum, Mr Maylard grasps the end at which he will commence to stitch with two sharp single hooks, and when the first stitch has been secured, their further use is dispensed with

The two ends of the round ligament are first firmly sutured together by one small mattress suture

Under ordinary circumstances three layers of sutures are required to close the wound in the abdominal parietes, the first includes peritoneum and the posterior wall of the sheath of the rectus, the second, the anterior wall of the sheath of the rectus, including also the posterior wall, should there be any doubt about the hæmostasis, and the third a layer of sutures for the skin

The technic of the introduction of these sutures is as follows The peritoneum is closed by interrupted sutures of catgut, placed one-quarter of an inch apart from each other, great care being taken so that the cut edges of the peritoneum are everted and not inverted, if such be allowed to take place, post-operative abdominal adhesions are not only a possibility, but practically a certainty

On the introduction of the suture, the knot is tied, the assistant grasps the double ligature one inch from the knot, and cuts it, one by one, as required, until the incision is closed

The posterior wall of the sheath may have a separate row of interrupted sutures, but this is not really necessary

The usual method is to use an interrupted suture, which is passed from the anterior surface of one rectus sheath, and brought to the anterior surface of the rectus sheath of the other side of the incision, this suture includes both layers of the rectus sheath and the contained rectus muscle Before bringing the edges of the skin together the wound is thoroughly swabbed with iodine This procedure is delayed until all the layers of the abdominal wall have been brought together, except the skin, so that there is no possibility of any of the iodine entering the abdominal cavity, and its object is the sterilization for any possible infection of the edges that might ensue during the various manipulations of the internal parts

The skin may be closed by either a continuous catgut suture, an interrupted silkworm gut suture, or by Michel's metal clips

When closed by a continuous catgut, and before the suture is tied, a gauze swab is taken, and rolled firmly along the whole length of the incision, so as to force out any blood or serum which may have collected between the edges during the closure of the wound After this has been done, the suture is firmly knotted and a collodion dressing applied When closed with clips or interrupted silkworm sutures, an anchor dressing is applied to the wound

If the abdominal wall is very thick, a combined superficial and deep continuous catgut or silk stitch is used This stitch has been used by Maylard for many years, but only recently has any publication dealing with the method been observed

In ANNALS OF SURGERY, February, 1918, part 302, Sir J O'Connor, K B E, of Buenos Aires, describes what he calls the Gallo stitch, for closure of the skin of the abdominal incision It would therefore be more correct to call

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it the Maylard-Gallo stitch, or method of uniting the superficial margins of abdominal incisions

Take a length of catgut and fix it at one end of the incision in the usual way, then enter the needle half an inch from the margin of the incision, carrying it down to its floor, and bring it out at a point exactly opposite that of entry, and at the same distance from the wound margin. The next stitch is the superficial one, the needle being entered one-eighth of an inch from the wound margin, taking only the thickness of the skin, and bringing it out at a point directly opposite to, and at the same distance from, the wound margin. This makes a most excellent suture, and by means of it subcutaneous and deep oozing are reduced to a minimum.

The anchor dressing consists of six-ply of butter gauze, rolled firmly together the required length, soaked in a one-to-seventy carbolic acid solution, and laid along the line of suture. No medicated gauze of any description is used, simply plain, white, sterile gauze.

When the abdominal wall is very fat, or when a ventral hernia has been dealt with, deep through-and-through silkworm gut sutures are used in the following way. A No. 6 silkworm gut is threaded on a large curved cutting needle, the needle is entered at from one-half to three-quarters of an inch outside of the cut margin, and is directed downwards obliquely towards the floor of the wound, which it crosses, and enters the opposite side, where it is carried through the subcutaneous fat for one inch, it then reënters the edge of the same side, and makes its exit through the skin, at the same distance from the wound, and about one inch from the point of entrance.

The method of tying these sutures is as follows. Three turns are taken, and the suture tightened to the required degree, either end is then separately taken and passed underneath the suture by means of a pair of dissecting forceps, grasped on the other side, and pulled through the loop left at the commencement of the procedure. By this means dragging on the skin and subcutaneous tissues is obviated, there is no tendency for the suture to cut into the skin, causing pain to the patient, and necrosis of skin and subjacent subcutaneous tissues.

By means of this stitch all possibility of a dead space existing between the edges of the wound is obviated.

The stitches are removed in from five to eight days after operation. To remove them, lift one end with a pair of dissecting forceps, and cut the strand between the knot and the skin, if this be done they are most easily removed, the important point to remember is that they must be cut at one or either end, between the knot and the skin, and not in the centre.

It is well to remember that when closing a transverse abdominal incision the patient, after the peritoneum has been closed, should always be raised to the horizontal position, prior to inserting the sheath or skin stitches, if this simple rule be borne in mind a great deal of time and trouble will be saved, since the edges of the wound tend naturally to come together.

If from any unfortunate circumstance it should be found necessary to drain either the peritoneum or the wound, it is done as follows

A piece of rubber drainage tube of the required size is cut a quarter of an inch longer than the thickness of the abdominal wall, and stitched into the skin at one or other lateral extremity of the wound with the end of the gauze drain brought through it, the diameter of the tube to be according to the size of the drain required, thus, if one have primary reason to pack any part of the abdominal cavity for the control of hemorrhage, a large-sized tube is used, but if the requirement be, say the drainage of an abscess cavity, a tube of a quarter of an inch in diameter would be quite sufficient. The reason for the drainage gauze being brought through a relatively rigid channel is, that if it were simply brought out between the layers of the abdominal wall, it would undergo contraction, on the principle of capillary attraction drainage would be impossible. It should also be noted that when gauze is used for drainage it is thoroughly soaked in bismuth paste, this adds immensely to its drainage powers. Occasionally, as when one has operated for a large ventral hernia, a cigarette drain is laid along the muscle sheath, and brought out at one extremity of the wound, this is removed at the end of the third day. All of these gauze drains are thoroughly permeated with a thirty-three per cent bismuth carbonate paste, which renders it markedly antiseptic, increases its powers of drainage, by assisting capillary attraction, and prevents the gauze from becoming adherent to bowel or peritoneum. There is also a strong possibility that it helps markedly to prevent the formation of intra-abdominal adhesions, and there is no doubt that gauze thus treated has not the irritating effect upon intestine that dry gauze has, also doing away with what in many cases would appear to be a contributory cause in the formation of a fecal fistula.

ADVANTAGES AND DISADVANTAGES OF THE TRANSVERSE INCISION

Advantages

- 1 Anatomically and physiologically correct
- 2 Does not destroy the nerve supply of the muscles
- 3 The muscular fibres being cut at right angles to their long axes, healing is more rapid and thorough
- 4 Almost perfect apposition of the wound surfaces after suturing, it being the natural tendency of the margins of the wound to come together so that there is practically no strain put upon the sutures at any time
- 5 As the fibres forming the anterior wall of the sheath are running transversely, and the stitches are entered at right angles, the risk of tearing of the fibres is greatly lessened
- 6 Easy access to any part of the abdominal cavity
- 7 Retractors rarely if every necessary, therefore surfaces of wound not bruised or injured
- 8 Less shock to patient, owing to absence of retraction of margins of incision

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- 9 Abundance of room, and complete freedom for all abdominal work
- 10 Complete view of abdominal cavity and its contents, therefore the risk of swabs or instruments being left behind almost nil
- 11 Easy delivery and replacement of viscera
- 12 No tearing of peritoneum when being closed
- 13 Practically perfect apposition of margins of wound, therefore no dead space for post-operative blood-clot, or serum, to collect and delay the healing process.
- 14 As the line of incision is in one of the lines of cleavage of the skin it is, after a few weeks, almost unobservable
- 15 Very little if any post-operative pain
- 16 If the patient be sick at any time subsequent to the operation, the pain in and around the incision is very slight, because the edges of the incision being firmly approximated, there is less tendency for them to separate
- 17 Drainage with a transverse incision is much more efficient
- 18 Post-operative convalescence as a rule, in uncomplicated cases, is practically uninterrupted, because there is less shock at the time of operation and less post-operative pain
- 19 Average length of time in bed is less
- 20 Post-operative ventral hernia is very rare

Disadvantages

As regards disadvantages, the only one of moment is the prolongation of the operation by perhaps two to five minutes, this, in the majority of cases, is negligible. It is questionable as to whether it does prolong the duration of the operation, because, while time is lost at one part, it is amply compensated for by the time saved in practically all other stages of the operation.

Mr Maylard has personally informed me that he has seen a ventral hernia occur, but I have never seen one either in any of his cases or in any of my own.

The only adverse criticism of the transverse abdominal incision which has so far been noticed is in the *ANNALS OF SURGERY*, part 391, p 632, where Doctor Meyer states that with this incision the layers of the abdominal wall do not come into as firm an apposition as they should, and that he was not using it as much as he did some years ago, from under the muscles one had for a time, secretion. One hesitates to criticize the technic of a man of Doctor Meyer's standing, but I must say that I have never had any trouble, nor seen any trouble occur in any case, where approximation of the wound margins had been accurately obtained. In one or two such cases where such trouble did occur, it was found upon investigation that two or three of the deep sheath sutures had given, and a small amount of oozing had taken place. It might also be mentioned that Doctor Meyer was dealing with a case of gastric carcinoma, and it is well known how slow and imperfect these cases are in their healing, due most probably to the imperfect nutrition of the tissues forming the abdominal wall. It is not doubted that many individual surgeons

have their own individual objections to it, but its superiority over the longitudinal incision is unquestionable, because it is anatomically and physiologically correct

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ACUTE INTESTINAL OBSTRUCTION
ENTERECTOMY, PARTIAL EXCISION, INCLUSION, POST APPENDICAL
INCIDENCE, TREATMENT OF STUMPS

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THIS essay has been indited with the intention of inviting surgeons to take stock of present methods of dealing with the most grave acute problem in general surgery, and if any of the suggestions herein contained should prove of any value in helping to diminish the incidence of acute obstruction of the bowels, or in enhancing the chances of surgical relief, the time and thought devoted to its composition will be more than recompensed

Adopting the motto "Avoid the abstract and stick to the practical," I commence by posing the question, what is to be done in case of acute obstruction, when a portion of the gut is found gangrenous? Before responding, one has to bear in mind that, from the moment the circulation of the bowel becomes impeded, splanchnic shock and systemic poisoning begin, and both intensify in compound ratio to the hours which pass until the obstruction is relieved. General symptoms often prove delusive guides as to the existence of this lethal combination, which seems temporarily to possess an insidious potentiality only requiring some slight surgical stimulation to unveil its effect with appalling rapidity, and whenever gangrene of intestine is met with, not only is it proof positive that the case has, for one cause or another, been sadly neglected, but there exist initial factors, poison and shock, which seriously handicap any attempt at human succor. And while primary knowledge of these unpropitious facts may tend, in a way, to alleviate the sense of dire responsibility which everyone feels when he finds himself confronted with this tragic affection, yet it in no way deflects from the duty to spurn finesse and, even at the risk of the dead stymie, ileus complete, to give every patient outside articulo mortis a surgical chance, remembering that conscientious work accomplished in the shortest time is the one thing most likely to snatch a victory, the master stroke being elimination of the morbid trio, eventration, undue manipulation and prolonged anæsthesia

With this preface I will endeavor to give a reply to the above question. Concentrate attention on the extent of the gangrene, carefully scrutinize the condition of the mesenteric zone, confine the attack to what is essential, and, as every moment counts, "force the game"

I do not hesitate to state that, next to having details of likely operations in clear mental perspective, there is nothing more conducive to operative celerity than, while the patient is being prepared (always including gastric lavage) personally to superintend the selection of instruments and drains, the threading of an adequate assortment of needles, the provision of an ample

counted supply of sponges, towels, and some rubber tissue, not omitting a few sterilized kidney basins, and the apparatus ready for any washing or injection which may be required, warming up the operating table, and last, and indeed not least, securing the help of two smart assistants

There is also a contingency which may seriously interfere with expeditious surgery in acute intestinal obstruction—assuming previous examination fails to give an indication—a very perplexing question arises at the start where to make the incision so as to get directly at the seat of mischief? I cannot conceive anything more demoralizing to a surgeon than, when entering the abdomen on a forlorn mission, to find his energy and time sapped, at the outset, in struggling to restrain inflated intestine from bursting out through the parietal wound, and if the site of lesion is not evident, and, as frequently happens, the distention is so great and the serous coat of bowels so friable that it is impossible to pass the gut methodically through the fingers in search for the constriction without causing numerous peritoneal lacerations. His position is truly pathetic, between the scylla of traumatism plus exposure and the charybdis of retreating without having reached the objective, both possessing one, and the same, mortal denominator, “Yet is their strength labor in vain”

These remarks are not penned on hearsay but on dire personal experience which incited me to publish a note in the *British Medical Journal*, November, 1918, on “the necessity to institute careful inquiry in every case of intestinal obstruction as to a previous attack of appendicitis,” or to an abdominal operation in which the appendix might have been removed for convenience, and “that regardless of the time which may have elapsed—detail revision of the patient failing to point the path—a four-inch incision should be made in the right semilunar line low enough to expose the ileocaecal region and right pelvis where the distal ileum will usually be found implicated in adhesions,” and while my experience may be exceptional, it suggests the personal conclusion that, excluding the era of iodine skin disinfection, and those which can be located before operation, in the majority of cases the obstruction of the small intestine will be encountered adjacent to the right pelvic brim, and that “the stereotyped central incision in such instances courts disaster, as in the search for the lesion the distended semi-paralyzed intestines are subjected to needless exposure and manipulation”

It is not pertinent to the context to analyze the psychology which inspires postponement of operation in acute appendicitis until what is academically styled “the cold stage” supervenes further than to interpolate that patients so treated who escape immediate translation to the glacial state remain endowed with a nest of adhesions which renders them likely candidates for premature mortification by the peristaltic contortions of their own small gut. And in parembolism I must add that I am unable to comprehend the mentation which complacently admits of “we’ll wait until tomorrow to decide” in a case of suspected acute intestinal obstruction

Acute Obstruction of Small Intestine—In a number of instances in which

stoppage is suddenly caused by a band or kink only a narrow ring or small knuckle of bowel is found gangrenous, and in quite a proportion of these necrosis does not extend to the fixed portion of the gut, much less to the mesentery, the fact of the circulation in the heart of the intestine remaining intact induces a hope that there might be prompt restoration of peristalsis in the tube if inclusion or excision of the moribund area could be effected without entailing subsequent obstruction by diaphragm or angulation. Acting on this hypothesis, I venture to submit a classification from the operative angle, and I trust the suggestion will be viewed merely as a humble attempt to find some means of reducing the terrible mortality—40 per cent—which attends surgical intervention as expressed in mediate or immediate enterectomy.

“A” In cases in which one finds that a complete circle of the bowel is beyond redemption, I recommend that lateral anastomosis and excision of the gangrenous gut be carried out in the following order of detail.

(1) The affected zone of intestine is drawn out through external wound, extruding a sufficiency, above and below, so as to facilitate the performance of lateral anastomosis at a convenient distance from the lesion.

(2) The protruded bowel is fixed *in situ* by sponges which are meticulously packed into wound so as to preclude any possible regurgitation into the peritoneal cavity during subsequent manœuvres.

(3) Coils of proximal and distal healthy bowel are approximated and held in apposition by an assistant while four Triollet catgut Lembert sutures, half an inch apart, baste the apposed loops together, each stay is tied when inserted and its free ends caught in a pressure forceps.

(4) An opening, by sharp scalpel, two inches in length, is then made, close to and parallel with line of stays, into the distal gut—as no clamps are employed a kidney basin is made to catch whatever escapes—and then a pressure forceps is applied about the centre of free edge of incision to act subsequently as a tractor.

With a large kidney basin in position, a corresponding incision is at once made into the proximal bowel, free vent is afforded for escape of contents (the more the better omen) and the centre of free edge of this wound is similarly seized with a forceps.

(5) Two assistants then make gentle opposing traction on adjoining stays, while a continuous through-and-through Triollet catgut suture (tautly secured to each stay in transit) seals the posterior segment, the ends of the “central” stays are then cut short.

The forceps previously attached to the free edges of wounds are now grasped by an assistant so as to indicate a strategic site for the insertion of two anterior “central” stays, the continuous catgut through-and-through suture is then carried on (as it approaches each stay the latter is tied and continuous suture knotted to it) until closure of the anterior segment is completed, the ends of stays are then snipped away, and the whole field is washed

with warm peroxide lotion, dried with bibules, and the anastomosed part is enveloped in a dry towel

(6) The gangrenous portion is then taken in hand, a catgut ligature is applied at least two inches, respectively, above and below the proximal and distal suspect limits, the intervening necrosed intestine is excised, any bleeding point in mesentery is immediately dealt with. A purse-string catgut Lembert suture is next inserted around the base of each intestinal stump, with a few snips of a scissors each stump is then freed from its mesentery just enough to render it easy for an assistant to invert it, with a dissecting forceps, into its corresponding lumen as the purse-string is being tied

(7) A jug of warm peroxide lotion (1 in 35) is again requisitioned, a general wash and brush up follows, everything is thoroughly dried, and bowel returned

Four or five through-and-through strong silk sutures close the parietal wound, leaving room at one angle for passage of two thick silkworm gut wisps which are so placed as not to adhere to any line of intestinal suture

"B" In some cases an incomplete narrow ring of gangrene results from constriction by band which in width more or less corresponds to that of the band itself, if this does not exceed one centimetre and the mesenteric zone is healthy, the affected coil is drawn out through wound and secured in place as before mentioned. Four equidistant long catgut Lembert stay sutures are then passed—skipping over the dead zone—through living proximal and distal gut, these sutures are not for the moment tied, their ends are respectively caught in forceps, the assistants with blunt hooks retract the loops of these stays well out of the way, while a kidney basin is placed in position and a transverse incision made through the whole extent of the gangrenous area (N.B., this incision is only made in cases where, after removal of the "external" obstruction, there is no consequent visible inflation of the distal bowel), thus free escape for contents is provided, when the flow ceases, the hooks are removed from loops, the forceps grasped and upper and lower intestine approximated, the stays are then tied and a forceps applied to each pair of free ends with which the assistants make opposing traction, while a continuous catgut Lembert suture, braced to each stay as it passes, completes the matter, the ends of stays being clipped away, the toilet, etc., is effected as in "A"

"C" The most difficult case for decision is the one in which a band, kink or twist has caused more extensive necrosis, the fixed portion of gut remaining suspect, and mesentery apparently uninvolved, the problem then arises, can infolding or excision of gangrenous section be accomplished without leaving an obstructive diaphragm or angulation? In order to clear perspective I wish here to mention that I cannot, as yet, recommend the adoption of either, if the belt of gangrene exceeds a width of one inch, anything above that commands the major procedure "A", but within this limit the complications mentioned can be obviated

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Three long catgut Lembert stays are inserted, as in above, into proximal and distal bowel, one along free border and one on each side midway between this anterior stay and mesenteric attachment, blunt hooks are then made to pick up loops and retain them clear of the field while a free crucial incision is made through the moribund segment, when the intestinal discharge has ceased, the loops of stays being still held aside, the four gangrenous flaps (made by crucial incision) are liberally excised with scissors, the stays are then drawn taut so as to facilitate inspection of the amount of angulation produced by approximation of the proximal and distal gut, two similar lateral stays are next inserted close to mesenteric line embracing as much or as little of the peritoneal coat, above and below, as may be judged necessary to correct any likely kinking by the anterior sutures, the five stays are then tied and a continuous catgut Lembert suture applied as in "B"

The part stays take in the above procedures possibly warrants a little amplification. They, from beginning to end, make for rapidity and good workmanship in that they point the line for the continuous suture, help to secure its tension, and in themselves, form a strong second line of defence. They are infinitely preferable to clamps, as they do not cause any devitalization of tissue, which by the way, in acute intestinal obstruction is already sorely attenuated by distention and toxic infiltration. They possess a sound surgical attribute, viz, they admit of seeing a bleeding vessel and tying it. They serve as excellent pliable tractors by which the operator can dominate at will the slippery, sloppy ground on which he has got to work, and consequently are the best insurance against an attack of "the tail wagging the dog," at a moment when one carries a heavy time handicap in a race for life in the most fatal of acute surgical affections.

Acute Colic Obstruction—In this catastrophe, if the problem as to the seat of lesion is not solved before operation, it may be taken for granted that what was mentioned as a contingent complication in acute "intestinal" is a certain one in advanced colic obstruction, and, owing to the enormous distention associated with the latter surgical intervention, as often as not ends in a tragedy. After a certain amount of prolonged pressure and manipulation necessary to retain intestinal balloons inside the abdomen, a rather sudden and unexpected relaxation of tension occurs which is apt to lure one on to proceed instead of beating a rapid retreat, but which in reality is the culminating exposition of intestinal paralysis induced by the superaddition of traumatic to preëxisting splanchnic shock. The curtain then drops as the anæsthetist whispers the epilogue—myocardial liquidation has begun.

Under such circumstances it is natural that one should seek for some mode of escape before the advent of the fatal loss of spring, and I cannot see anything promising on the horizon except in all cases in which through examination and careful study of the history fail to give a clue to the whereabouts of the obstruction, to make a right semilunar incision, explore gently for a few minutes, and if there is no result, proceed at once with the preliminary step of closing the wound by inserting four or five long through-and-through

strong silk sutures, and without knotting catch the ends of each in a pressure forceps. Then coax the left hand supinated and extended, between parietal peritoneum and bowels, over to the right iliac fossa, where two fingers flexed forward point the site for an incision large enough to allow the external inferior sacculation of the cæcum to be drawn outside and maintained there momentarily by forceps. The semilunar wound is then rapidly closed, and a dressing applied, covered by rubber tissue and a towel, and immobilized by fixation forceps.

Attention is then turned to suturing exposed cæcal sac to margin of iliac wound in such a manner as to preclude any subsequent backward percolation. The patient is then gently rolled over on his right side to the edge of the table, a basin is placed in position, and a stab made into gut sufficiently large to give free vent to its contents.

I have had gratifying results with this method, and whenever feasible, I like to employ the external inferior sacculation for drainage, as its site is strategic, it seems anatomically adapted for the purpose, it occasionally closes spontaneously after the obstruction disappears, and can be closed by operation without encroaching unduly on the lumen of cæcum.

The early insertion of the through-and-through silk closure sutures may require some explanation. These sutures, in place, help to prevent a rush from within as the wound can be promptly occluded by traction on their forceps and thus diminish pernicious handling of bowels. They afford good support for any temporary packing, their presence tends to obviate separation of layers of parietal wall during operation. Owing to internal pressure their introduction may be an arduous business which had better be effected, so as to save valuable time, before the fatigue stage supervenes, and the fact of their being in, affords a comfortable homeward-bound feeling, which, on occasion, is not to be despised. If long threads of silk are used the loops can be readily hooked away from field so as not to cause any operative inconvenience.

It may have been observed that I advocate an incision in the right semilunar line for both acute colic and acute "intestinal" (unplaced) obstruction, the reason for doing so being that if one reflects on the statistics of acute abdominal lesions of which 70 per cent are credited to appendicitis, if to this be added the incidence of pyloric duodenal and biliary affections, the ratio of involvement of the right as compared to the left abdomen must certainly stand not less than eight to one, and, knowing that the most frequent cause of obstruction is the legacy peritoneal agglutination following infective processes and operations for their relief, the deduction is, to say the least, logical that, given no direct guide, the chances are greatly in favor of finding the lesion in the right abdomen. And as to the systematic search for obstruction by passing the gut through one's fingers, my experience dictates that this can be (when serous coat permits) as effectively done through a right semilunar as through any other incision.

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As to making a separate suitable opening in right iliac fossa for cæcal drainage, I am all in favor of it, for it appreciably diminishes the risk of subsequent virulent infection, and its consequences, in the large primary wound

Peritoneal Seclusion of Stumps—In 1903 I received my first object lesson as to the danger of leaving raw endothelial stumps in the peritoneal cavity, in the case of a well-known young lady on whom I performed double oophorectomy for cystic disease, and as the appendix was very much in evidence I thought it expedient to remove it. This was done by a method in vogue at that period, viz, ligation and touching the stump with a disinfectant. As there were no adhesions, the whole operation was simplicity itself. Ten days later, she suddenly developed acute intestinal obstruction, the wound, under anæsthesia, was opened up, and to my intense disgust, I found the stump of the appendix glued to that of right ovary with a coil of congested ileum clutched in the adhesion. An uneventful convalescence ensued. Since then appendical stumps have, when possible, been buried in the cæcal wall or covered with an omental plaster.

The most recent reminder occurred in a married lady on whom I performed right oophorectomy in October, 1920. As customary the appendix, for insurance reasons, was also removed and stump interred. On June 3, 1921, she was suddenly seized with violent abdominal pain and vomiting, which her doctor attributed to "acute gastritis", various enemas and purgatives were ineffectually administered during the following four days. She was brought into hospital on the fifth morning, the abdomen was distended, stercoraceous vomiting incessant, no general symptoms beyond a distressed facial expression. A test enema was at once given, without result, as soon as the stomach was delivered of a basinful of dark green foul liquid she was transferred to the operating table. As parietal, vaginal and rectal examinations gave no indication, I made the usual right semilunar incision, immediately some coils of distended congested ileum bobbed up in the wound which were returned by bibule pressure, and the left hand was then introduced into right pelvis where it found a loop of ileum bound down, after the manner of a Christmas cracker, by a tense band about one centimetre in breadth and ten in length, passing from below cæcum to base of right broad ligament, the left index finger was gently insinuated beneath band and strictured gut and former elevated (without rupture) for inspection, then we found the silk ligature which had been placed nine months previously on meso-appendix, snugly encircling the band about half an inch from its upper point of fixation, affording a direct and positive proof that the band had originated in and included the stump of the meso-appendix. A small cæcal scar indicated the tomb of the appendix, and the right ovarian stump was free and had contracted to the size of a pea. The band was excised and gut drawn up into wound, a belt of gangrene, corresponding to width of band, involved the greater part of free zone of bowel. Stays were inserted, and as peristalsis had

visibly resumed its function, the necrotic segment was infolded (without incision) by stays and a continuous Lembert catgut suture. Prompt recovery followed.

Some months previous to this, while pondering over the matter of how to reduce contact to a minimum when dealing with the stump of an infected appendix, I stumbled into a very simple method of secluding the stump of the appendix and that of meso-appendix by one ligature in one peritoneal pocket, and, "en passant," I may add that my colleague, Doctor Fehilly, and I have employed it in many cases and find it as useful as it is practicable.

(1) The meso-appendix is ligated and appendix isolated in the usual manner, the ends of ligature are not cut away.

(2) A curved intestinal needle is then attached to one end of this ligature and a three-insertion (two lateral and one anterior), purse-string suture is passed, at a distance of about one-third of an inch, around the base of the appendix, the anterior point of suture is purposely inserted beneath the anterior longitudinal band.

(3) The needle is then removed and the ends as well as the loops of the purse-string are left loose and kept out of the way while the appendix is clamped at level of cæcum separately ligated, and cut away.

(4) The ends of the "ligature suture" are then sought for, and as they are tied together (the assistant with a dissecting forceps pushing the appendical stump backwards) both stumps instantly and definitely disappear from view—only two things touch the raw surface of the stump of appendix—the knife and the dissecting forceps.

The above is the first instance in which I found the stump of the meso-appendix *in flagrante delicto*, but I have often suspected its complicity in pelvic adhesion jungles, however, knowing the tendency that peritoneum has to adhere to any raw surface, I think I may safely advocate burial of this stump, particularly as both it and its mate (of the appendix) can be readily interred together with the same bit of string.

Peritonization of Stump After Salpingo-oophorectomy—After periodic attempts at rotating the ovarian or salpingo-ovarian stump downward and suturing it face backward on the anterior shelf of its broad ligament, I have definitely abandoned the procedure as I found it, almost impossible to avoid, even with blunt instruments, the occasional formation of a troublesome intra-ligamentous hæmatoma, and moreover, the manipulation necessary for such adjustment endangered the security of the pedicle ligature.

Instead, I have adopted a much more simple and more readily applicable method which can be always resorted to without "asking for trouble," viz, a web, about one or two inches square, is excised from the omentum and plastered over the surface of stump, and a piece of fine silk (or the ends of the ligature) is made to secure it in bonnet fashion, around the neck of same. In infected cases I always employ catgut instead of silk for ligation of pedicle and for fixation of this omental "patch."

RECTAL AND VESICAL INCONTINENCE RELIEVED BY OPERATION

By JOHN G. SHELDON, M.D

AND

EDWARD P. HELLER, M.D

OF KANSAS CITY, MO

M. K., male, age twelve years, was brought to the Vineyard Park Hospital in June, 1921, for relief of incontinence of urine, with a history that he had never had any control of his bladder, and had always had to wear a diaper. At night, and when recumbent, drainage is less. He was born with an imperforate anus (Figure 1). When 24 hours old the attending physician inserted a knife into the anal region, and succeeded in entering the pouch of the rectum. He sutured the cut edges of the rectal pouch to the skin (mother's statement). These sutures did not hold, and a second operation was performed three days later.

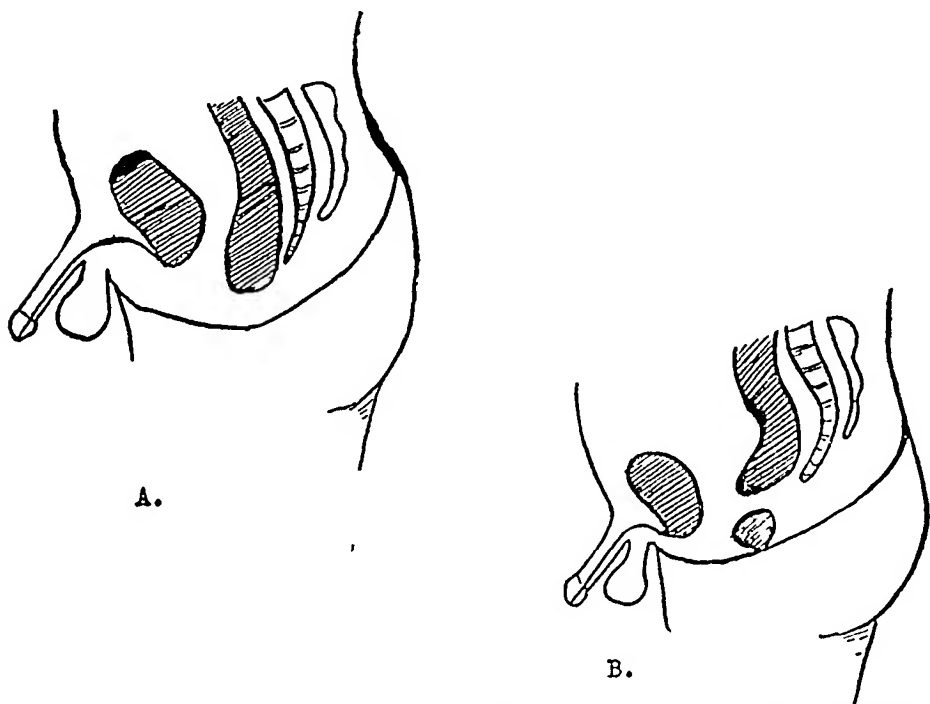


FIG. 1 —(Stewart) A Imperforate anus — the original condition in the case herewith reported
B Imperforate rectum. In the present instance there was no evidence of an anal pouch.

This operation was successful as far as establishing an anus was concerned, but there was no control of the bowels. At the age of three, he was taken by his parents to a surgeon in the Northwest, who performed a muscle-flap operation (mother's statement). Two weeks later the flaps had to be cut as no bowel movements were possible. The child's condition was now as before operation. Nothing was done, however, until two years later, when he was taken to a large clinic in the Middle West, where a "puckering-string operation was done" (mother's statement). At this time, an attempt was made to correct the enuresis by passing a catheter at regular intervals. Two weeks after return to his home, he was in the same condition as before operation. He remained in this state of incontinence of urine and feces until November, 1919, when he came under our

observation When admitted he had an incontinent anus with no sphincter that could be discovered There were scars about the anus, the result of previous operative procedures It was decided at this time to attempt to provide a rectal sphincter from flaps of the glutei maximæ Since four weeks after operation, (a space of 18 months), he has had perfect control of his bowels No attempt was made to correct the enuresis, and it is for this condition that the child has been brought back for treatment

Family History Negative There are three younger children in the family, all of whom are physically perfect

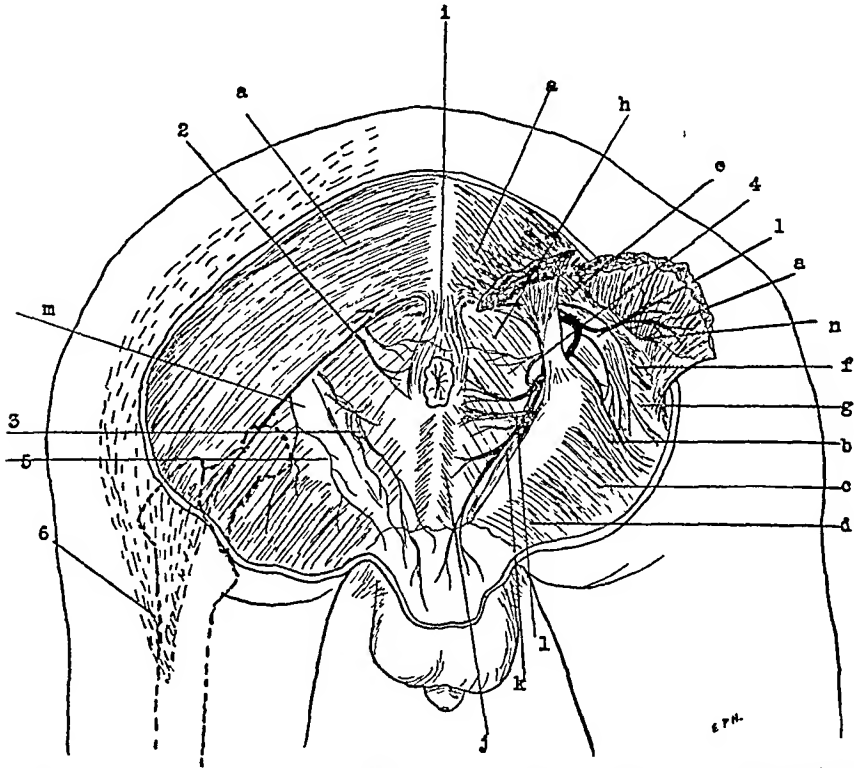


FIG 3—(Treves after Rudinger) The male perineum a gluteus maximus, b semi-tendinosus and biceps, c adductor magnus, d gracilis, e pyriformis, f obturator internus, g, quadratus femoris, h, levator ani, i external sphincter, j bulbo-cavernosus, k ischio cavernosus l transversus perinei, m tuberischi, n, inferior gluteal nerve (branches) o sciatic nerve, p, inferior hemorrhoidal vessels and nerve, q, superficial perineal vessels and nerves r pudic (internal pudendal) nerve (cut) and pudic artery, s, perineal branch of posterior cutaneous of thigh t semi-diagrammatic representation of attachment of gluteus maximus (a modification added by one of us)

Physical Examination A well nourished boy, surgically negative except for scars over both gluteal regions, (Figure 2), and obliteration of the gluteal folds, the result of the previous operation in which a muscle-bundle from each gluteus maximus was swung around the rectum There is no control of micturition, and a diaper is worn constantly The urine drainage is worse when he is up and about—the urine dribbling from the urethra at a slow steady rate On assuming the recumbent position the flow is somewhat less

Description of First Operation—Formation of rectal sphincter (November, 1919) With the patient in the reversed Trendelenburg position, long incisions were made in line with the fibres of the gluteus maximus muscle on either side, and extending approximately three inches above and three inches below the tuberosity of the ischium on each side (Figure 2) Having isolated the mesial fibres of the gluteus maximus on one side, a search was begun for branches of the in-

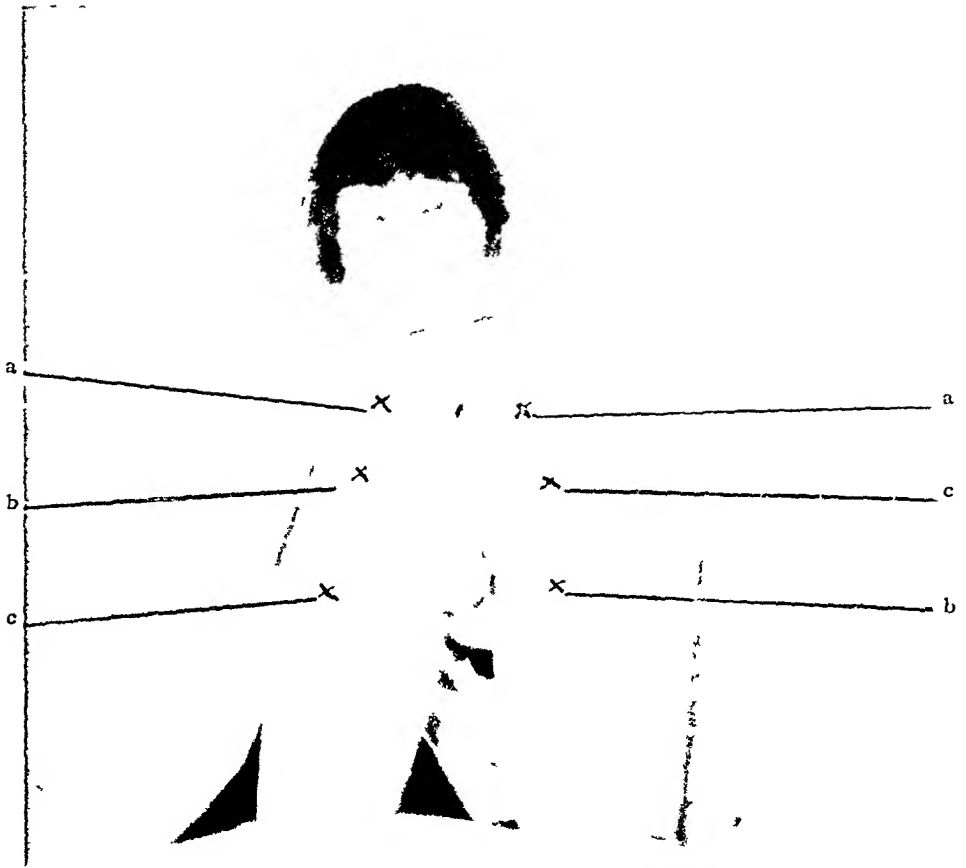


FIG 2 — (Photograph taken 18 months after operation) a Upper end of incisions, b lower ends of incisions c position of ischial tuberosities The patient has purposely been placed in the same position as when operated upon It will be noted that the gluteal folds have been obliterated because of the underlying muscle bundles Note the deep perineal crease

RECTAL AND VESICAL INCONTINENCE RELIEVED

ferior gluteal nerve (The inferior gluteal nerve arises from the posterior divisions of the 5th lumbar and the 1st and 2nd sacral nerves, it leaves the pelvis through the great sacro-sciatic foramen, below the pyriformis, and divides into branches which enter the deep surface of the gluteus maximus muscle) For success it is necessary that a good innervation be secured for the flap (Figure 3)

Having isolated a bundle of muscle fibres about 2 inches in breadth, with the necessary nerve supply, the bundle was separated from the upper angle of the wound down to the femoral attachment. Here a strip of periosteum was removed

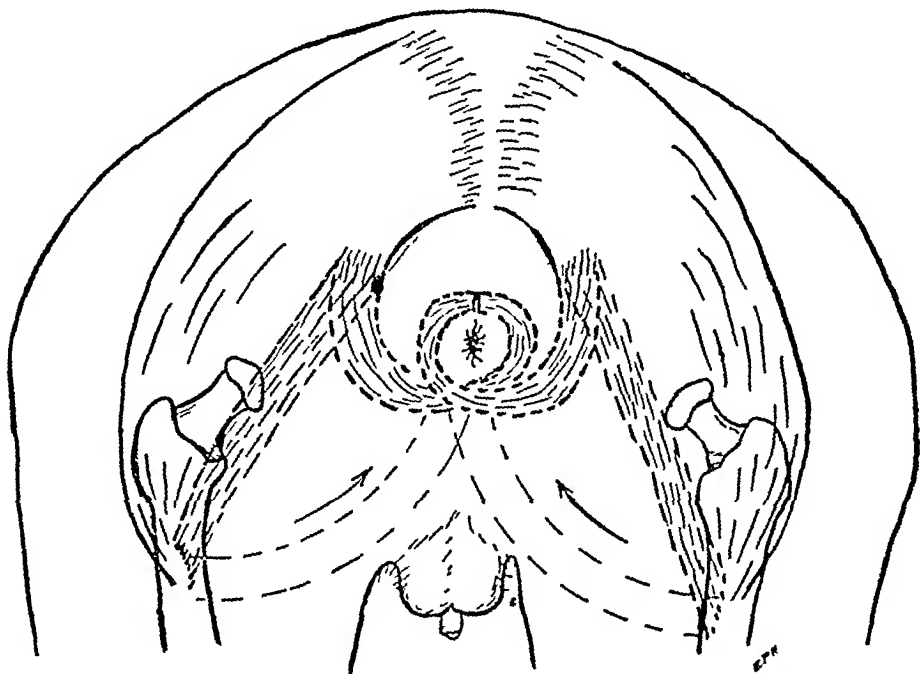


FIG 4—Diagrammatic representation of the method by which the sections from each gluteus maximus were detached and swung around the anus beneath the superficial structures of the perineum, and sutured together

with the muscle in order to prevent fraying of the ends of the fibres, and to assure secure anchorage for the sutures which were to unite this muscle bundle with its fellow of the opposite side

By the same procedure the other gluteus maximus was isolated and a similar muscle bundle, with a large branch of the inferior gluteal nerve, separated throughout the length of the incision, and including the periosteum of the femur below the great trochanter

By blunt dissection a channel was tunnelled completely around the rectum—or better, around the anal canal. By retracting the undermined skin, and by sliding first one muscle flap and then the other around the rectum as shown in Figure 4, the ends of the flaps were brought into apposition, and sutured together with chromic catgut

After hæmostasis, a rubber drain was inserted into each wound to care for the secretions of the first 24 hours, and the wounds closed with silkworm gut sutures. The patient was made comfortable by changing his position from one side to the other. Healing of the wounds was uneventful. At the end of the third week, there was some evidence of control of the bowels. At the time of dismissal—the end of the fourth week—there was control of the bowels during the day. One week after returning to his home in Idaho, the boy states that he discovered how to control his bowels, and that gradually this control became involuntary. Now his improvised sphincter remains contracted, or on guard, so to speak, at all

times except during the act of defecation. A point of interest is that the sphincter contracts independently of the remaining portions of the gluteus maximæ.

Description of Second Operation—Correction of vesical incontinence, June 17, 1921

In view of the previous history, the success of the first operation, and on the assumption that a fetal type of bladder was responsible for the persistent incontinence of urine, an operation was agreed upon for the relief of the enuresis.

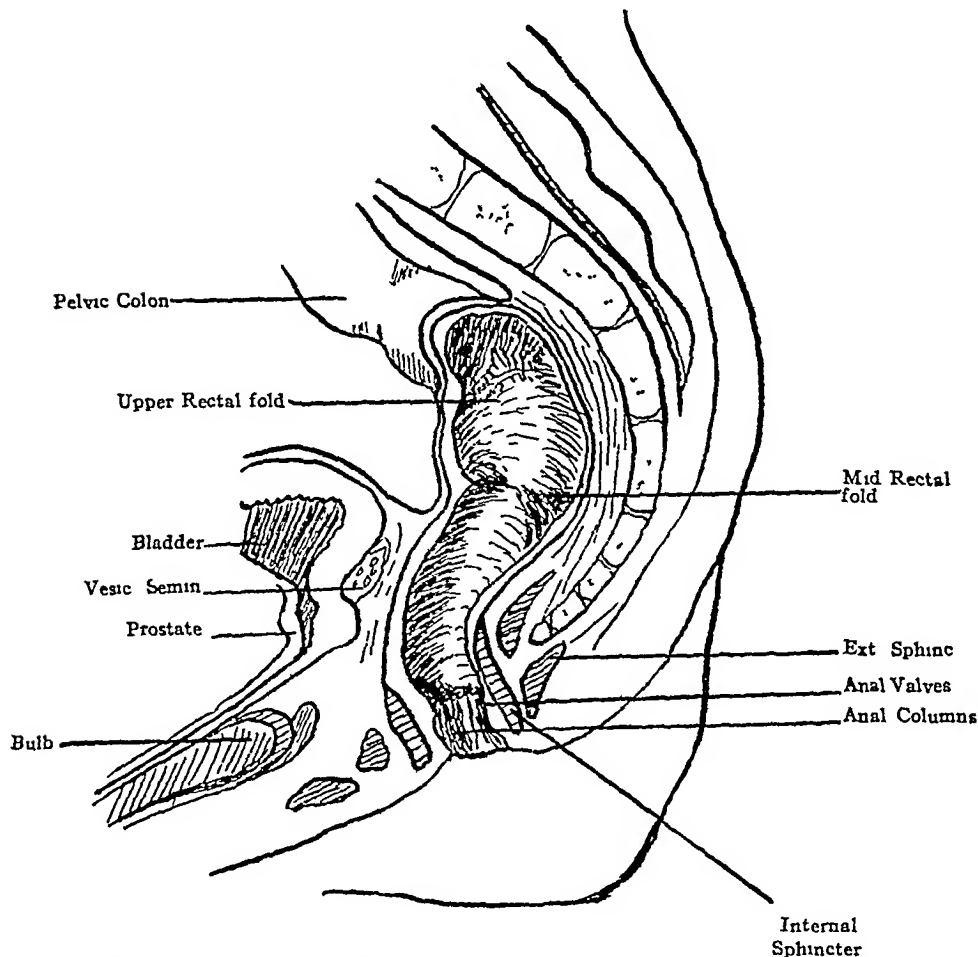


FIG 5—(Treves after Prof A M Paterson) Diagram showing the stages of the rectum and the anal canal on mesal section. This figure is interposed to illustrate the normal arrangement of the structures about the anus and rectum. In the first operation reported herewith 1* will be seen that the muscle flaps take the place of the internal sphincter and to a large extent, of the external sphincter also.

A three inch suprapubic incision was made, and the structures carefully inspected layer by layer. Much to our satisfaction, our assumption proved to be correct, for on arriving at the peritoneum, the urachus was found to be patent up to within two inches of the umbilicus, and both hypogastric arteries were pervious and of good size. These three structures were divided and ligated properly on a level with the upper limit of the fundus of the bladder. The bladder was then pushed well down into its proper position in the pelvis. (See Figure 6) A short rubber tube drain was inserted down to the prevesical space, and the wound closed with silkworm gut sutures.

In order not to leave undone a procedure which might aid in his recovery, a circumcision was performed.

RECTAL AND VESICAL INCONTINENCE RELIEVED

As far as the wounds were concerned, recovery was uneventful, the rubber drain was removed the day after operation, and the sutures were removed from the abdominal wound on the seventh day. He was up in a chair on the fifth day and was walking about on the ninth day.

As to his bladder condition, the following notes were taken from the Progress Record. First day post-operative, there was some discomfort at glans penis, and some burning on micturition—due probably to the circumcision. Second post-operative day, uneventful except for frequency of micturition—capacity 25 to 50 c.c. urine, with knowledge of start of act of micturition. Fifth post-

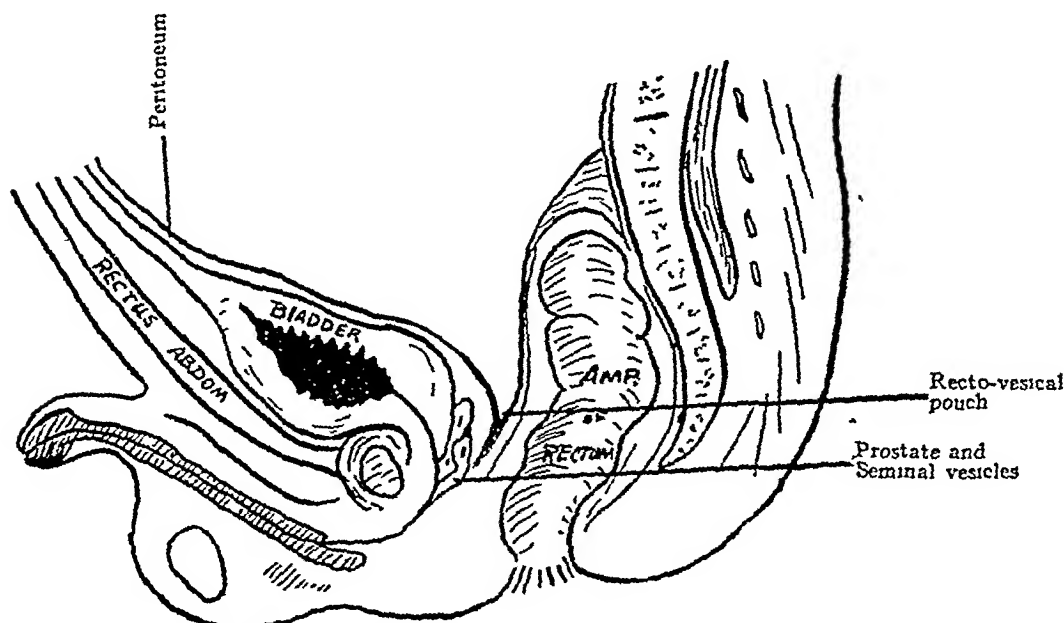


FIG 6—(Gray's Anatomy after Corning) Mesal section through pelvis of a new-born male. This diagram shows the position of the bladder as found at the time of operation (second operation herewith reported) with the exception that the cavity of the bladder extended further upward into the urachus. The urachus or middle umbilical ligament is the impervious remains of the tubular canal of the allantois which existed in the embryo and a portion of which expanded to form the bladder. It passes upward from the apex of the bladder between the transversalis fascia and the peritoneum, to the umbilicus, becoming thinner as it ascends. It is composed of fibrous tissue, mixed with plain muscle fibres.

operative day almost complete control of micturition, and increase in capacity of bladder to 300 c.c. Sixth post-operative day, no longer kept urinal over penis, but requested it at intervals. Control absolute. Still some frequency. No dribbling. Ninth post-operative day—no dribbling while walking about. In knee-chest position for 20 minutes while photographs of gluteal region were being taken and no dribbling occurred. Eleventh post-operative day was dismissed, and to date has had no recurrence of enuresis.

Comment—It has been stated in the foregoing that the form and position of the bladder were believed to be the cause of the urinary incontinence. The diagnosis and the operative procedure were based on the Goltz theory of micturition. In 1874 Goltz¹ evolved the theory that micturition is due to the following causes: The presence of urine in the urethra resulting from distention of the bladder, contractions of the bladder, or positions of the bladder or patient, were responsible for the desire to micturate. While it is true that the work of Guyon and others apparently disproved the correctness of this theory, we have several clinical observations that support it in some cases. The formation of a rectal sphincter involved purely mechanical and anatomic considerations.

CONCLUSIONS

In view of the operative findings and result obtained in this case, we shall investigate with interest the position and shape of the bladder in all cases of urinary incontinence

Regarding the rectal operation, this case, and an experience with two others of a similar nature, prompts us to record mistakes which were made in our first operations of this type (1) The fibres of the gluteus maximus should not be severed, but should be detached with the periosteum at the site of insertion on the femur, (2) the muscle flap should be ample, at least an inch in diameter—even in children, (3) if possible, the nerve supply of the muscle flap should be investigated, and retained even if a large portion of the muscle must be incorporated in the flap

REFERENCE

¹Archiv fur die gesammte Physiologie, 1874, Bd VIII, S 478

SECONDARY FOCI OF TUBERCULOSIS IN THE SPINE IN POTT'S DISEASE

BY CHARLES W PEABODY, M D.

OF BOSTON, MASS

STUDY FROM THE ORTHOPÆDIC CLINIC OF THE MASSACHUSETTS GENERAL HOSPITAL

ABOUT six months ago on the Orthopædic Service of the Massachusetts General Hospital a patient had been scheduled by the writer for operation who was to have a bone graft for Pott's disease of the dorsal spine, an extensive process having destroyed the ninth and involved the eighth and tenth dorsal vertebræ Just before the hour of operation during, the weekly "ward rounds" on the service, the X-ray plates of this patient among others were demonstrated to the members of the staff At this point, to the writer's chagrin, the Chief of Service, Dr R B Osgood, called attention to a vertebral body lying at the lower edge of the exposed field Its outlines were much obscured by the shadow of the cylinder of the Rontgen tube, but on close inspection it appeared to be distinctly wedge-shaped Between it and the process above lay two normal bodies and intervertebral discs, and for this reason no attention had previously been directed to it The significance of this finding in relation to the proper operative procedure was of course apparent, and the latter was postponed pending further X-ray study Subsequent plates were confirmatory, showing a typical deformity of the second lumbar vertebra and the disappearance of the disc space below it In other words a secondary focus was present in this spine Unless this second focus had spontaneously healed during the post-operative recumbency, which is unlikely, as in this clinic this period is not a very extended one due to the internal fixation, its progress would have been aggravated by reason of the increased strain from the immobilization of the overlying spine, and the patient would have been as bad off with his lumbar Pott's as he had been with the dorsal But while relief was felt at the timely discovery, it was generally felt too rare an occurrence to be seen again

A few months later a patient presented himself for examination by the writer in the Out Patient Department who had had a bone graft for a mid-dorsal Pott's about eight months previous He was wearing a light back brace but complained of the same pain and weakness in back as before operation and localized a point of tenderness a little lower down X-rays were taken, and to our surprise the plates, showing the graft in place in the spines of the sixth to eleventh dorsal vertebræ, also showed a disappearance of the disc between the last dorsal and first lumbar and a deformity of the body of the latter The process above centered in the ninth dorsal and involved the two adjacent bodies, leaving a normal segment between it and this lower one Recalling the case first cited, we forthwith looked up the Röntgenologist's interpretation of the pre-operative plates of this second patient, with the

discovery that apparently this second lesion had been distinguishable even then, although the wording was a little misleading and gave the impression that the lesions were in continuity. After some search these original plates were also found, and, while the lower area was not clearly in focus, comparison of the two sets showed that a definite secondary lesion clinically unrecognized had existed prior to operation.

Within a few days after this incident the writer examined and sent into the ward for study a young Italian laborer with a large low abdominal mass, a contracted hip, and indefinite symptoms in back suggesting a low lumbar or pelvic tuberculosis. The initial X-ray examination revealed an early destructive process in the fifth lumbar vertebra. As this did not appear very far advanced it was thought by the staff insufficient to explain the large psoas abscess present, and further X-ray study of the spine was made. This revealed an advanced Pott's disease with encircling abscess shadow in the lower dorsal spine.

The findings initiated a discussion in the clinic of all three cases, which brought out the fact that a patient had recently been operated on by the fusion method for a tubercular process developing some time after a previous bone graft, but at a slightly lower level than the first.

Thus within a space of less than six months four cases of distinct secondary foci in the spine had come under observation in one clinic, yet the prevailing opinion therein was that such a condition was exceedingly rare. Two questions presented. Were we working under a considerable misapprehension regarding the incidence of an important complication of Pott's disease, or have the usual methods of examination been too limited to reveal this phase? The first question seemed easy to answer, and the Index Medicus was turned to, but in the titles for the last ten years no mention of this matter of secondary foci was found. Did this indicate that it was a condition too rare to be of importance, or too common to merit emphasis? With the latter possibility in mind the standard text books on Orthopædic Surgery were consulted. Out of five examined only one made reference to secondary foci in the spine, that of Whitman mentioning a series of 1356 cases in which sixteen, or less than eight-tenths of one per cent showed lesions in two regions. But these findings were obtained from tracings made of the spine and not as a result of X-ray examination. Still convinced that the problem could not be so rare as apparently indicated by the scarcity of reference in the literature, it was determined to seek information from the fairly considerable number of cases of spinal tuberculosis on record in this hospital. Diagnosis files were found to contribute nothing in this regard. Dispensary record notes contained little detailed information and were equally unproductive. On the other hand scrutiny of a portion of the mass of ward patient records proved so time consuming that some short-cut was sought. It seemed apparent that in the last analysis the only confirmative evidence of absolute value would arise from the X-ray data on a case, and hence the most productive endeavor would be in the records of this department, which was inclusive of both O P D and ward

cases The diagnoses in all examinations made since 1913 were found still on file Those finally and definitely diagnosed as "Pott's Disease" or "Tuberculosis of the Spine" were segregated,² amounting to 315 patients (the total number of examinations made on these patients being of course several times greater, appearing in succeeding years) The original descriptive cards of these examinations were then consulted for a detailed interpretation of the X-ray picture For the first six-year period these were found disappointing in value, in that a detailed report was lacking, and a summary only appeared, such as "Old Pott's Spine" or as "Tuberculosis of Dorsal Spine" However

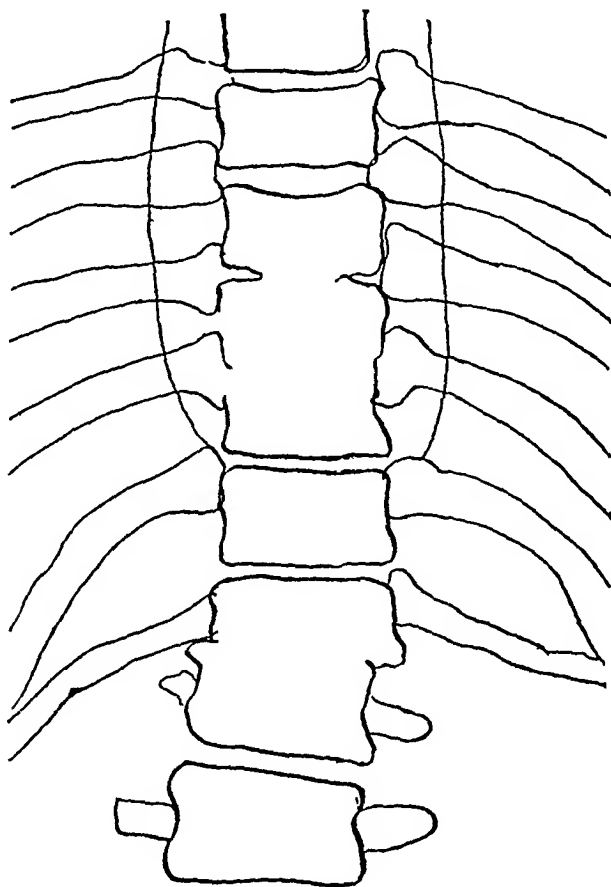


FIG 1—Case VII—Jos W A-P view of dorso-lumbar juncture showing typical lesion in lower dorsal spine and also one in upper lumbar area

in this group several instances occurred in which even in the abstracted form note was made of two foci being present From late 1918 to date the records contained the complete dictation of the röntgenologist, and in this latter period were found five cases in addition to the four described at the beginning of the paper with a definite observation of secondary foci The reported findings of the thirteen patients follow Each report concluded with the diagnosis of tuberculosis

Group I Two hundred cases, four with secondary foci, or two per cent.

Case I Stephen T, No 2193 "A pathological process involving first and second lumbar and also one involving the fourth and fifth lumbar "

Case II Mario L , No 41376 "A destructive process involving twelfth dorsal and first lumbar and intervertebral disc, also third and fourth lumbar and disc "

Case III Morris R , No 37866 "The seventh dorsal is partly destroyed, there is also a destructive process involving ninth and tenth dorsal "

Case IV Carline V , No 41826 "Rather extensive destruction of body of the fifth dorsal vertebra, process seems confined to the body, the seventh is distinctly wedge-shaped, diagnosis deferred " ' A year

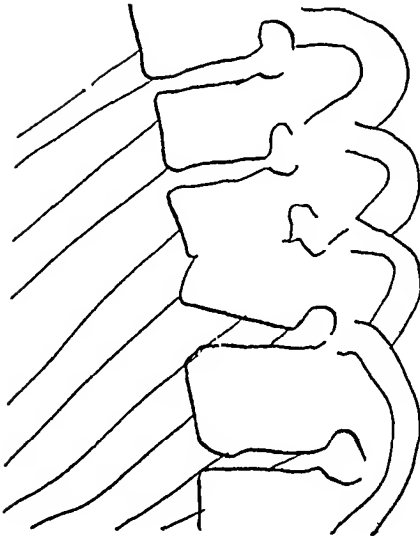


FIG 2—Case VII—Small plate focussed over lower dorsal and showing appearance of lesion here in lateral view

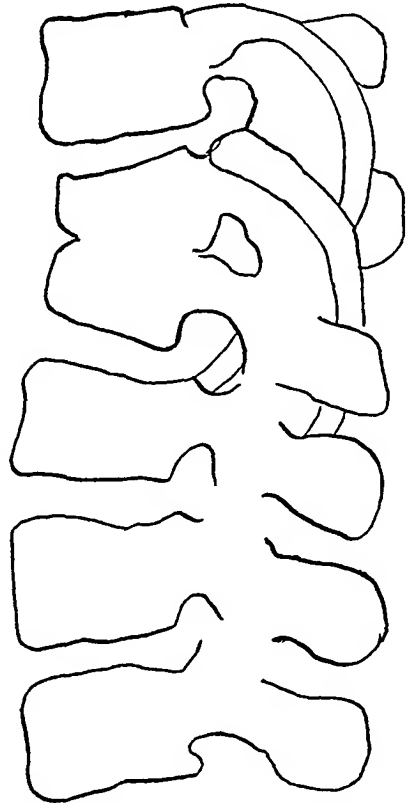


FIG 3—Case VII—Lateral view of lesion in upper lumbar spine

later examination showed abscess shadow and definite diagnosis of tuberculosis was made

Group II One hundred and twelve cases, nine with secondary foci, or eight and two-tenths per cent

Case V Lorenzo B , No 64014 "There is a destructive process involving eighth and ninth dorsal vertebrae and disc, also a process in first and twelfth", and first lumbar

Case VI Amelia D , No 57041 "The tenth and eleventh dorsal are fused, the first lumbar and disc below are also affected "

Case VII Joseph W , No 37537 "The ninth and tenth dorsal vertebrae are partly destroyed, there is also a process between the first and second lumbar "

FIG 4—Case X—Ephthius S. Lateral view of lumbar spine showing fusion of second and third vertebral bodies. Above them is a normal segment and at the top of the plate evidence of the pathology in the dorsal spine can be made out

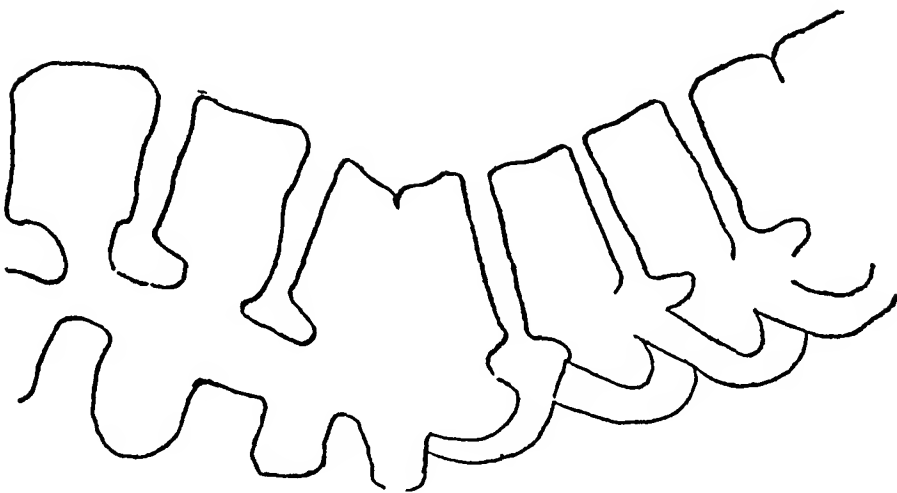


FIG 5—Case X—A-P view including both lesions. A dense abscess shadow overlies the dorsal one

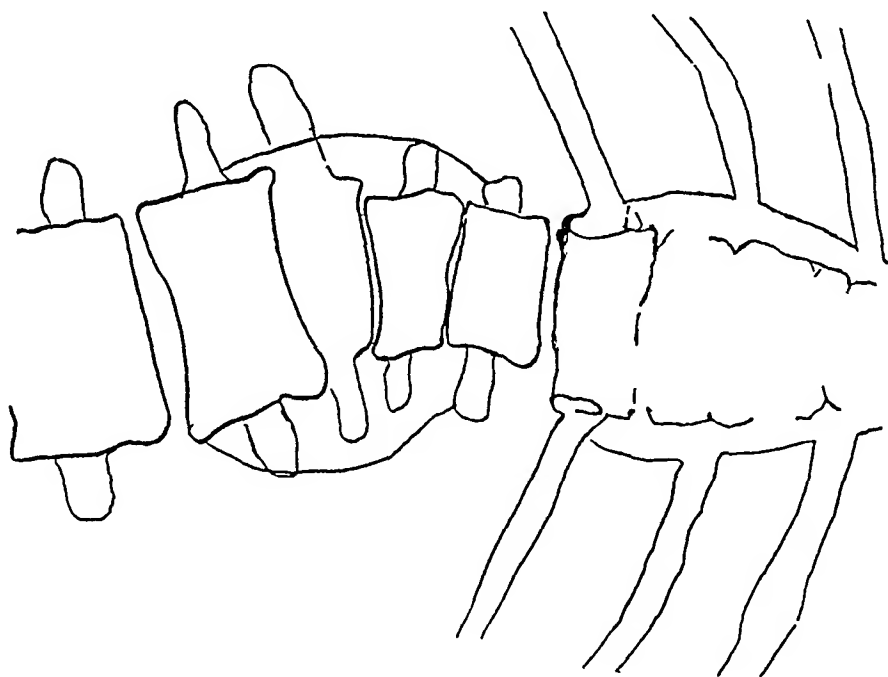
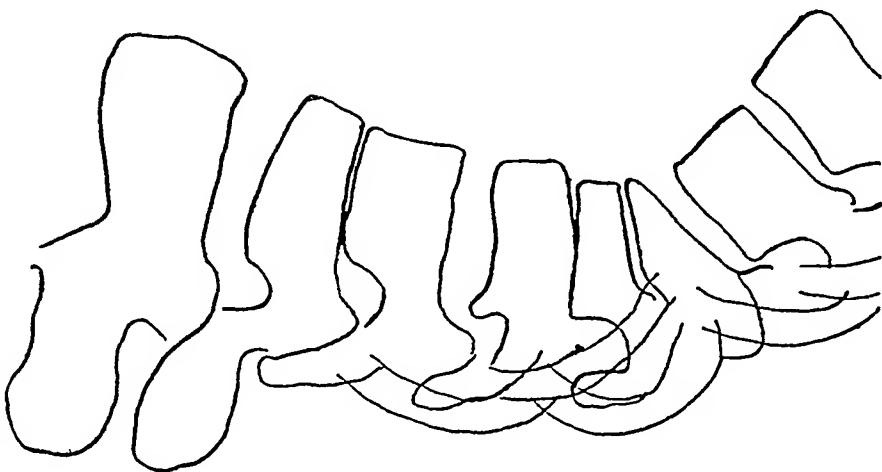


FIG 6—Case XI—Michael S. Lateral view of dorsal spine with a destructive process shown and a normal subjacent area



Case VIII Grace T, No 49324 "There is a destructive process involving the first and second lumbar There is a second process involving the tenth and eleventh dorsal "

Case IX James H, No 54518 "A destructive process involving seventh and eighth dorsal with disappearance of intervening space The tenth and eleventh are also affected and the space narrowed "

Case X Ephthis S, No 64418 "An extensive destructive process involving ninth, tenth and eleventh dorsal vertebrae, with an abscess shadow present " At a later date "plates confirm above and show second lumbar to be wedge-shaped and disc below destroyed "

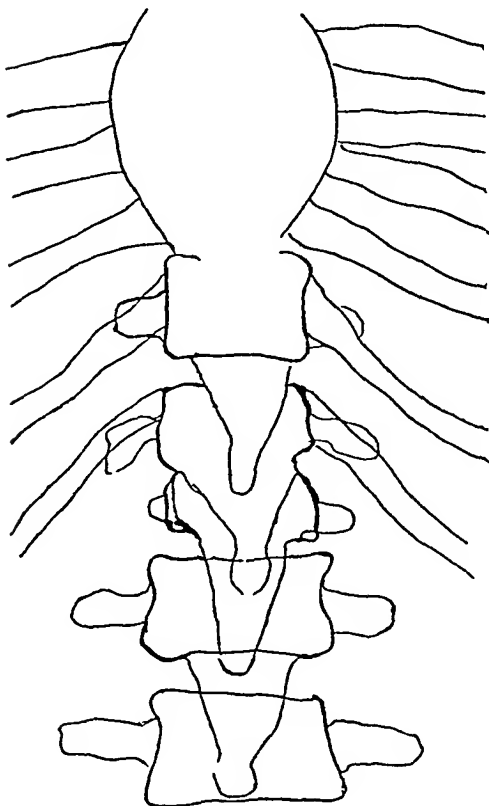


FIG 7—Case XI—Dorso-lumbar area in A-P view showing evidence of an additional focus in lumbar spine

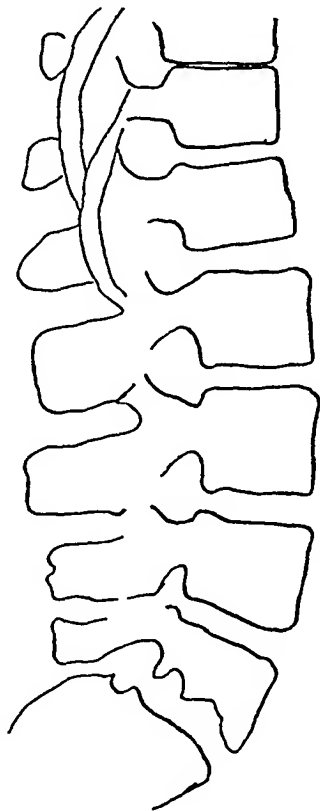


FIG 8—Case XII—Sebastiano C Lateral of lower spine the fifth lumbar being seen definitely diseased, and at the top of the plate the disappearance of the disc between the eleventh and twelfth dorsal indicates another process in this region

Case XI Michael S, No 63955 "Extensive destructive process involving ninth, tenth and eleventh dorsal The twelfth is normal Bone graft can be made out in sixth to eleventh There is an additional process between the first and second lumbar "

Case XII Salvatore C, No 72831 "Plates show destructive process in body of the fifth lumbar Additional plates show involvement of the ninth, tenth and eleventh dorsal vertebrae with surrounding abscess shadow "

Case XIII Mary C, No 57877 "Tuberculous process involving

Fig 9—Case XII—Process in lower dorsal seen in A-P view, abscess shadow present

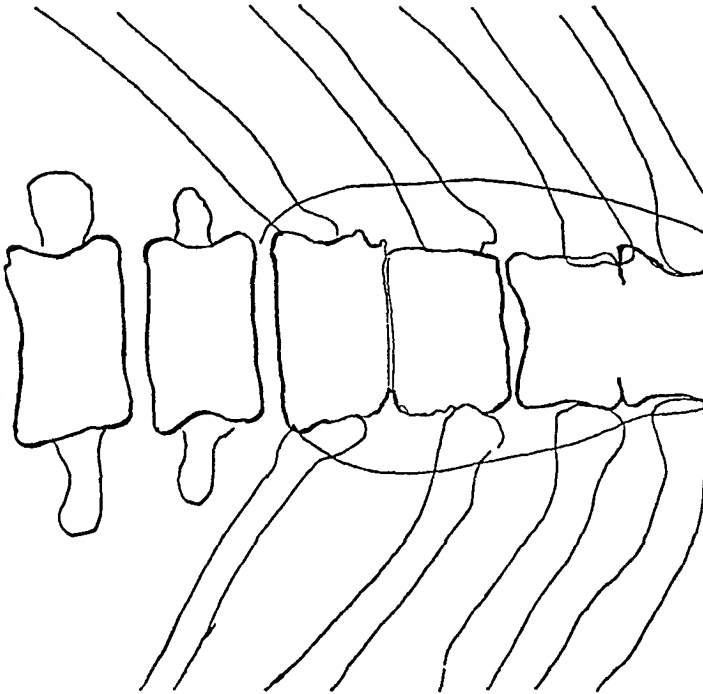
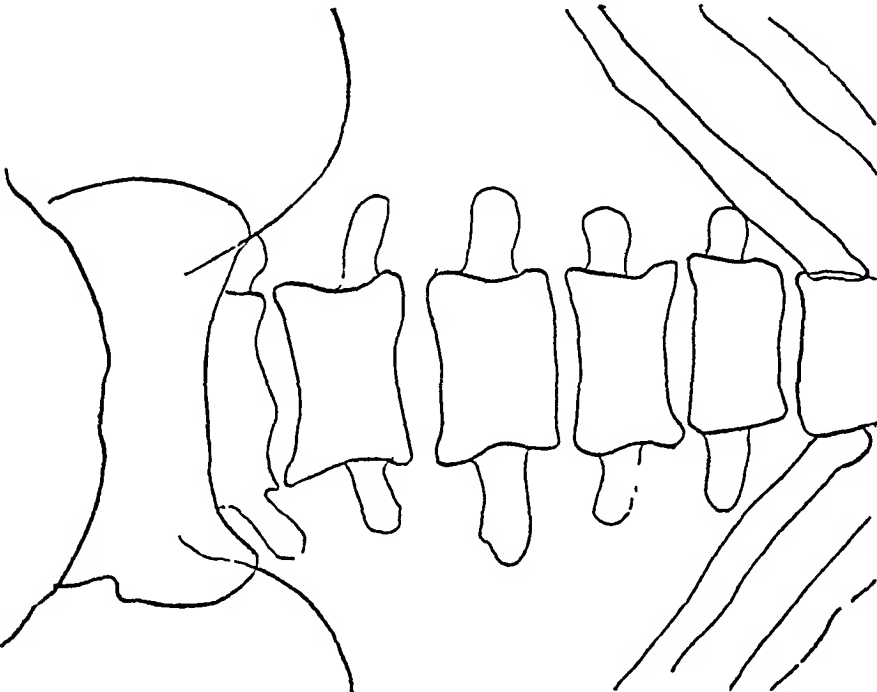


Fig 10—Case XII—A-P view of deformity in fifth lumbar



ninth, tenth and eleventh dorsal vertebrae with bone graft in place
There is a process below the graft involving the twelfth and first lumbar "

Total of groups I and II equal 312 cases with thirteen secondary foci found, or four and one-tenth per cent for the whole number

NOTE —The illustrations are limited to those cases which have been personally observed by the writer, i e the four mentioned in the introduction, listed as cases ten to thirteen inclusive, and also case seven, whose two spinal foci were simultaneously recognized and appropriately treated several years ago, but who is still under treatment for a subsequently developing tuberculous hip The X-ray negatives of all these patients were

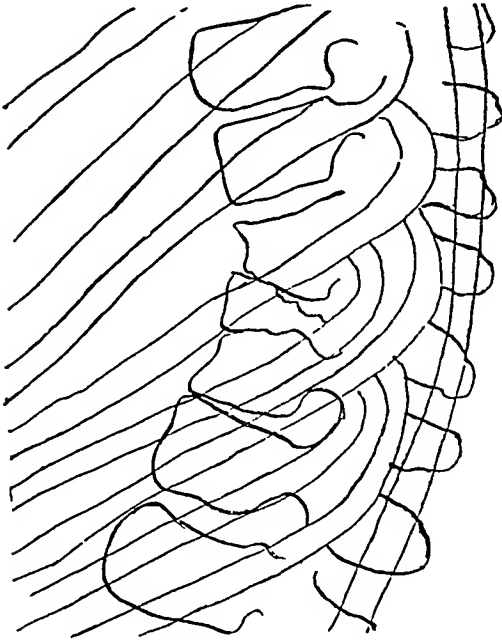


FIG 11—Case XIII—Primary focus in dorsal spine seen from side The shadow of the bone graft in this case could be seen along the spinous processes

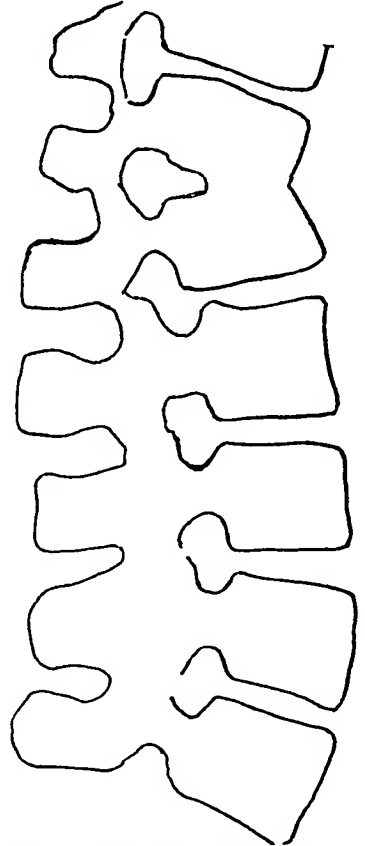


FIG 12—Case XIII—Lateral of lumbar area showing disappearance of disc between the first and second bodies

sufficiently distinct when examined on the illuminated screen for all clinical purposes, but unfortunately proved not sufficiently clear to photograph successfully for reproduction here Accordingly tracings of the vertebral bodies were made over the original illuminated plates, and are here shown photographed without alteration

This limited group of statistics thus gives an incidence rate for the whole of about four per cent , the second period over eight per cent , with the first only two per cent In spite of the discrepancy between the rates of the two groups, it may be that the rate in the second is nearer the real incidence than the percentage of the combined total, a fair inference being that the brief summaries given in the records for the first period did not indicate all the

TUBERCULOSIS IN THE SPINE IN POTT'S DISEASE

findings in each case that might have been observed in a reading of the plates, as found in the detailed reports available in group II. The writer, furthermore, is inclined to put forward the suggestion that the highest figure given may be below the real incidence of this condition. Reasons which may be advanced to support this suggestion are as follows: (1) In almost every case the discovery of the second focus has been more or less by chance, that is neither clinician nor roentgenologist were searching with this in mind. (2) In a very considerable number of these Pott's cases the plates taken

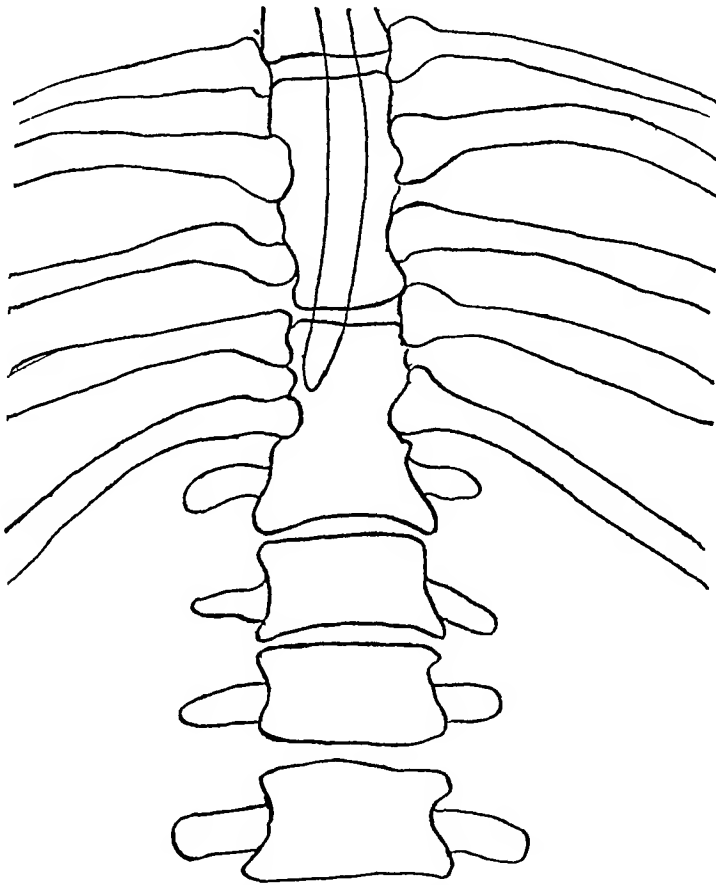


FIG. 13 —Case XIII —A-P view of lesions shown in two foregoing figures

included only a very limited area of spine. This procedure may well be open to criticism in view of the present findings, but was practiced for reasons of economic necessity, and because of circumstances about to be mentioned. (3) The majority of the cases had one focus much further developed and probably much older than the other, in other words the major focus may be sufficiently developed at time of examination to be recognized and accurately located clinically. It is generally the custom to send patients with a request for an examination of a specified portion of the spine, the involved vertebra often being named, and the technician, with the same purpose in mind, to get a sharply defined plate, adheres closely to the request, and is unlikely to repeat the exposure over other areas. Hence unless the clinician has demanded an extensive examination, and with a clinically well defined

lesion he has hitherto seen no reason so to do, only a closely adjacent lesion is likely to be discovered by this method. In view of these circumstances, then, it may be that a routine search for further lesions would show a somewhat higher incidence of secondary foci than any of these figures.

From the pathological point of view speculation naturally arises as to the mode of spread of this process. Are the lesions separate hæmatogenous infections from a common distant source such as the alimentary tract, or is the second the result of organisms thrown into the blood stream by the first, or is the new focus a direct metastasis by spread of the bacillus via lymphatic or connective tissue avoiding in some peculiar way the immediately adjacent segment? No definite answer seems possible now. There is certain evidence, however, in favor of the third possibility. In all of the cases found the lesser lesion has occurred at a lower level than the greater, that is, presumably, the subsequent focus below the original. In many the shadow of an abscess was seen around the upper lesion. From this it is possible to imagine a pocket of pus (the "ichor pocket" of the text books) working down next the vertebral bodies, and to conceive of erosion occurring, not in the early stage of formation, but later, when the pocket had reached a slightly lower level and where the pressure would be greatest, such as at an indentation made by the protrusion of a intervertebral disc. In the third case described at the beginning of the paper the two foci were separated by about five normal vertebræ, but in this patient an abscess had apparently formed very rapidly (his symptoms all being of very short duration), filling the iliac fossa, so that this route of spread extended all the way down to the new focus in the fifth lumbar. Such a conception of spread is purely theoretical, but if sufficient attention can be drawn to this general problem, post-mortem evidence may accumulate to explain and substantiate this phenomenon.

From these findings it may be concluded that very careful clinical examinations and a close cooperation between clinician and roentgenologist are indicated in the treatment of tuberculosis of the spine, to rule out the presence of the not uncommon secondary focus. The case cited in which this condition was recognized by the X-ray man and not till six months later by the surgeon has had a well appreciated moral in this clinic. Also that, as the second lesion seems to develop closely subjacent to the first and usually when an abscess shadow is present at the first, attention should in particular be directed toward the spine below an established lesion, and especially in those cases with abscess formation.

In summary it may be said that in tuberculosis of the spine secondary foci, separate but characteristic, are more common than generally supposed, and that a routine search should always be made for such.

NOTE —The writer wishes to express his obligation to Dr R. B. Osgood for many valuable suggestions in the preparation of this article.

POSTURE AND THE CERVICAL RIB SYNDROME

BY T WINGATE TODD, F R C S (Eng)

OF CLEVELAND, OHIO

PROFESSOR OF ANATOMY IN THE WESTERN RESERVE UNIVERSITY

IN 1911-1913 I was engaged in an investigation of the brachial plexus and the skeleton of the shoulder and the thoracic inlet with special reference to the cervical rib syndrome. In this investigation several papers were published dealing with the anatomical features concerned and with the clinical condition itself especially as regards the vascular condition (see bibliography in 9). Certain features of this work have been taken up by others and amplified. In particular it served as the starting point for the very careful researches of Stopford upon nerve injuries in the war (*e g*, 6, 7). The relationship of vascular conditions noted in Stopford's cases to nerve injury rests, as did the similar condition found in my own cases of the cervical rib syndrome, simply upon clinical evidence together with the inferences drawn from the detailed innervation of the nerves of the limbs shown in this laboratory by Kramer² and Potts⁴. This is of course insufficient evidence and it was intended to continue the investigation further so that this and other dubious points might receive some elucidation. The claim that degeneration of nerves causes alteration of vessels in the same area has been many times discussed, always with inconclusive results (*e g*, Spiller, W G, 5). Recently Horrax has reviewed the work of the war years upon peripheral nerve injuries¹ and refers to the decortication of arteries as practiced by Leriche. No further review is necessary here but it must be remarked that removal of the fibrous arterial sheath with its contained sympathetic nerves, as carried out by Leriche³ for a distance of ten centimeters or even more, cannot be done without considerable local disturbance. It is not therefore beyond all question that consequences in the limb are attributable to the sympathetic interference and that alone.

Accordingly the outbreak of war found R G Pearce and myself engaged upon the destruction of the sympathetic nerves to the forelimb of the dog, a comparatively easy operation without great inconvenience to the animal. Owing to circumstances beyond our control we were unable to finish this work and our results, so far as they went, were negative. It is not intended here to discuss this particular phase of the problem which will be left for the present with the statement that our work is still incomplete. Another line of investigation has however now brought some definite results and it is to this that I desire to draw immediate attention.

It is well known that posture has a definite relation to the cervical rib syndrome. The symptoms occur in the pregnant or recently delivered woman. The position of the shoulder relative to the thoracic inlet has an important bearing upon the subject and the symptoms may equally well occur in the absence of cervical ribs. Altering the posture may bring immediate relief by reducing or removing pressure. It is this relation to posture and the

curious fact that the thumb or even more frequently the index finger first shows indications of the syndrome which determined me to attempt to produce the symptoms posturally so that I might observe the form of onset and possibly the reason for earlier affection of the radial side of the hand. Accordingly in 1913 I formed the habit of sleeping with the right arm stretched out almost vertically under the head. This was uncomfortable for a time but the habit was soon acquired and rapidly became perfectly restful. I had supposed that within a short time some result might be attained but this turned out not to be the case. The posture having become comfortable it was continued with some interruption until March, 1921.

In January, 1921, tingling was noticed in the right index finger and thumb and slight indefinite loss of sensation. There occurred previously a little aching in the course of the nerves along the pre-axial and post-axial borders of the limb both above and below the elbow. It was not possible to determine which nerves exactly were the seat of this aching. The aching is still present at the time of writing (April 9, 1921), but is now confined to the post-axial border immediately above the elbow. Pressure on the aching area causes immediate tingling in the sensory distribution of the ulnar nerve. Similar pressure on the normal left arm evokes no response.

The tingling referred to in the previous paragraph was almost at once aggravated by immersing the hand in hot water. It was a dull irritating sensation, not exactly a pain but comparable with that sensation left after firm pressure on the gum close to the necks of the teeth. One would almost automatically rub the finger, this in no way relieved the sensation but rather aggravated it. Cold did not have an aggravating influence as heat did. This abnormal sensation is still present (April 9th) and affects the entire ball of the thumb but no other part of this digit, the whole of the sides and palmar surface of the index finger, and sometimes the radial border of the middle finger. It does not remain at uniform intensity but varies very greatly and may be absent altogether.

The index finger and thumb became swollen in February, 1921. Along with the swelling there appeared some paronychia, irregular desquamation of the epidermis and unusual separation of the nail from its bed. The last mentioned feature gave the impression that the nails were growing rapidly. Measurement of the weekly growth compared with that of the sound side showed this to be an error. The swelling and paronychia continued until March 30th, when the posture was altered, after which some improvement occurred. Fig 1 shows the condition of the index finger compared with that of the sound side on March 29th just before the experiment was stopped. Defective nutrition of the nail is apparent in the horizontal wrinkling. The raising of the nail from the finger in consequence of the swelling accounts for the difference in shape of the two nails and the apparent increased growth of the right nail. Irregular desquamation on the same date is well shown in Fig 2. At first sight it might be thought that the appearance of the right index finger was the result of formalin irritation. My skin has never been

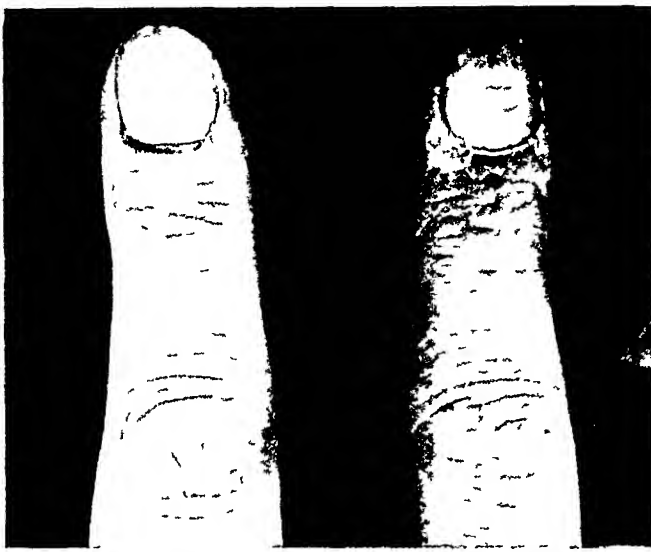


Fig 1—Right and left index fingers on March 29 1921 Note paronychia and defective desquamation on light The nutrition of the nail is deficient The difference between the two nails is accentuated by the raising of the right nail from its bed in consequence of the swelling of the finger there is no increased growth

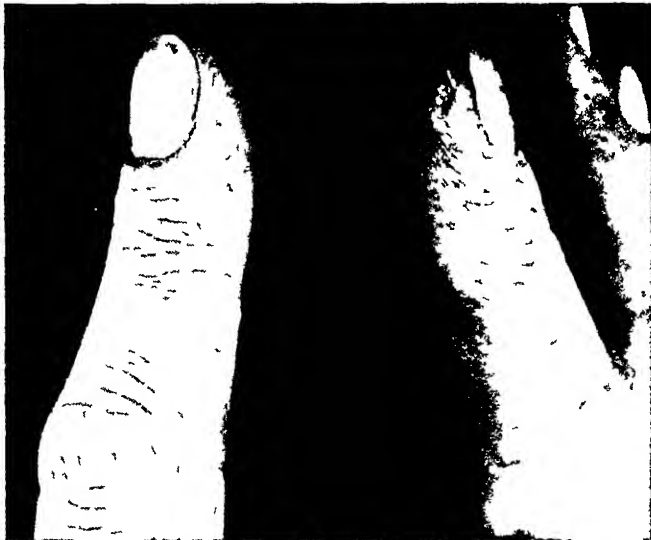


Fig 2—Same fingers same date Note irregular desquamation of epidermis on right

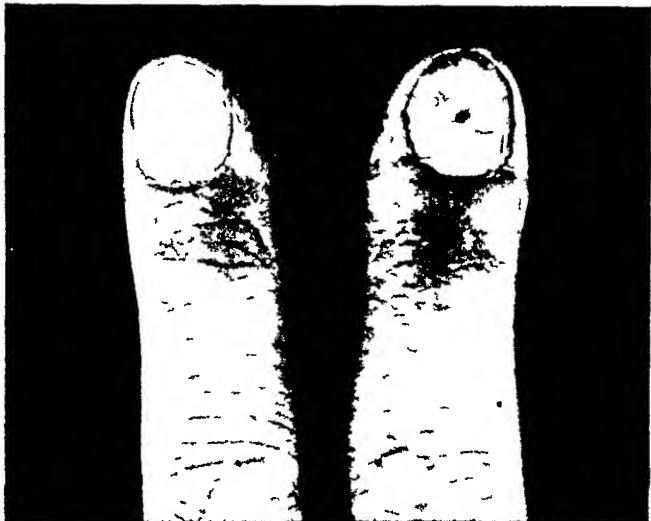


Fig 3—Same fingers April 9th Note the swelling of the right finger around the nail This type of swelling with a smooth shiny skin first appeared on April 8th It has disappeared again by April 12th

POSTURE AND THE CERVICAL RIB SYNDROME

subject to formalin irritation and the hands had not been in formalin for several weeks previous to the appearance of the condition noted

In association with the paronychia, sensation became increasingly blunt and at first I attributed this to thickening of the epidermis and swelling of the finger. In particular there was great difficulty in finding the keys of a typewriter with this finger which became useless for the purpose. Slight change also occurred in the hand-writing, this may be auto-suggestion. The finger still stumbles (April 9th) on the typewriter in spite of the absence of swelling.

On March 30th, the photographs for Figs 1 and 2 having been taken, it was considered wise to terminate the experiment by altering the sleeping posture, since the condition of the fingers had begun to interfere with routine duties. The initial symptoms of the cervical rib syndrome had made their appearance and had been duly noted and it seemed unwise to await further symptoms. There had been no cyanosis or any undue heat or redness of the affected parts. Further, if vascular symptoms were to appear later one could not rule out the paronychia as at least a contributory cause and the experiment would be just as inconclusive as previous experiments upon animals. It was, however, April 5th, before duties permitted a full examination of the affected fingers. On that day after suitable precautions had been taken to secure complete quiet and freedom from interruption, the fingers were carefully investigated by a colleague as regards sensation. There was no wasting or apparent muscular disability. The following is the result of this examination.

Tactile sensation —A small piece of absorbent cotton was used

Dorsal surface —A small area of insensitiveness at tip of thumb and distal part of second phalanx index finger near the nail bed. Tingling sensation all over distal phalanx and around nail.

Palmar surface —Insensitiveness on ulnar margin and adjacent area of ball of thumb, also on ball of index finger. Distinct tingling over distal part of second phalanx. No area of tingling on thumb.

Compass test —Nowhere on either thumb or index finger was it more difficult to distinguish the separate points of the dividers used than on the normal side. On the radial side of the palmar aspect of the second phalanx of the index finger and on the ulnar side of the palmar aspect of the distal phalanx of the thumb the divider points could be separately felt three millimeters apart. Elsewhere on these digits it was necessary to have the divider points five millimeters apart in order to obtain the double sensation. The same results were obtained upon the normal side.

Pain —Elicited with a fine needle in a needle holder

Dorsal surface —Tingling sensation over ulnar side distal phalanx of thumb and radial side of third phalanx index finger. No loss of sensation.

Palmar surface —Tingling sensation entire surface second and third phalanges. No loss of sensation. The tingling elicited by stimulation with the needle was exactly the same as that evoked by the absorbent cotton. There was some delay in sensation in occasional spots on

the palmar aspect of both affected phalanges of the index This may have been due to failure of the needle to penetrate the skin properly Delay was more frequent and more definite in testing temperature It was not apparent to light touch or the compass test

Heat—Water just boiled was used in a small phial This necessitated very frequent renewal

Dorsal surface—Tingling sensation over entire surface of distal phalanges only of thumb and index finger Some delay in irregularly placed spots in both locations

Palmar surface—Tingling along ulnar margin and adjacent area distal phalanx thumb, and along radial border and adjacent area second and third phalanges index finger There was in addition tingling in distal part of first phalanx of index only Some delay everywhere

Cold—The test was elicited with ice

No alteration of sensation Some delay in radial border third phalanx index finger front and back, and on dorsal aspect ulnar border thumb

Comparison of this record with the distribution of the median nerve as reinvestigated by Stopford⁸ shows that only some of the fibers are involved

On April 8th subjective tingling with increased heat in the affected fingers and waves of heat sensation in the arm generally set in The index finger especially began to swell and the skin to become shiny This condition lasted through the night but began to diminish next morning Fig 3 was therefore made to show the appearance before it should entirely disappear This was the first indication of any vascular disturbance

During the month of April occasional attacks of causalgia of even briefer duration occurred The fingers were in a very sensitive state Any local irritation, such as the application of formalin or photographic solutions, clapping of the hands or mechanical work in the laboratory shop, would light up a fresh attack Holding the arm in the old posture for an hour or so would bring about the same result

At this date (May 5th) the fingers are almost normal once more There is no loss of sensation and the typewriter can be used as before the symptoms appeared Apart from a slight hypersensitiveness to heat and irregular desquamation with dryness of the skin there is no disability

May 16th, the fingers are now healed and sensation is everywhere normal

The subject of the experiment is thirty-six years old and his history sheet is clean except for infantile disorders and otitis media He is well built, healthy and weighs 180 pounds There has never been any tendency to circulatory disturbance or local cyanosis, and the reaction to cold is normal There is every reason to believe that the prolonged retention of the peculiar sleeping posture, intermittent though it was, has *some* causal relation to the symptoms described The experiment failed to bring forward any evidence relating to vascular changes and though it emphasized the commencement of the symptoms in the index finger and thumb it suggests no reason for this distribution That the symptoms rapidly clear on change of posture con-

firms the established method of treating such cases in clinical practice. But the real reason for recording the experiment is the emphasis which it places upon the relation of posture to this symptom-complex with the obvious corollary that appropriate questioning may elicit the fact in certain cases that some apparently simple and harmless habit is really in part the cause of the symptoms which will disappear if that habit be broken.

SUMMARY

It is possible to produce the cervical rib syndrome experimentally by posture alone. Since this is the case it may be the explanation of some instances at least of the disease occurring in the absence of anomalies at the cervico-thoracic junction.

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THE INTRA-ABDOMINAL OPERATION FOR FEMORAL HERNIA

BY G PAUL LAROCHE, M D

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COMPLETE cure of abdominal hernia entails complete removal of the entire sac and as much as feasible of the adjacent redundant peritoneum above the hernial neck and orifice. No hernia is completely cured unless completely removed. The best incision for sac removal gives safe and most direct access to the neck and surrounding peritoneum through which may be accomplished enucleation and complete removal of the sac with least trauma to the structures involved.

In *Surgery, Gynecology and Obstetrics*, November, 1919, I described an intra-abdominal method of approach to, and removal of the sac and adjacent redundant peritoneum for the cure of inguinal and femoral hernia. By this method these purposes are completely accomplished with maximum safety from injury to the vas deferens, the urinary bladder and large blood-vessels. Adherent and diseased omentum and bowel may be adequately and safely separated from the sac and adjacent peritoneum, other organs and structures in the pelvic portion of the abdomen may be properly explored and treated through the same incision, the cremaster, internal oblique and other overlying muscles and fascia may with minimum trauma be separated from the sac and preserved for utilization in wound closure, during the final stage of enucleation, the sac and adjacent peritoneum are pulled upward away from the hernial orifice and canal and away from the bladder and large blood-vessels, and finally after excision of the sac and redundant adjacent peritoneum about its neck, the peritoneum may be sutured to structures well above and away from the previous hernial orifice. This latter consideration has obvious advantages over the method of making traction from below through which there is some liability, during ligation or suture, even by experienced surgeons, of unintentional anchorage of the peritoneum to fascia or muscle in the region of the hernial orifice or canal, to be followed by prompt return of the hernia or at least bulging at the site of the orifice.

There are some additional advantages of this method of approach incident to the location of the skin incision above the zone of infection within the hairline and from the fact that with the finger, a piece of gauze or blunt instrument within the sac, the line of cleavage between the sac and overlying muscle and fascia is more easily identified and enucleation more quickly accomplished with the least mutilation of overlying muscle and fascia.

Finally, with the field of operation entirely open, the surgeon may, after close inspection, choose the most suitable method of wound closure (canal obliteration), and whatever plastic procedures may seem useful in the individual case.

Many surgeons of large experience and good judgment have expressed



FIG 1—A large sized femoral hernia

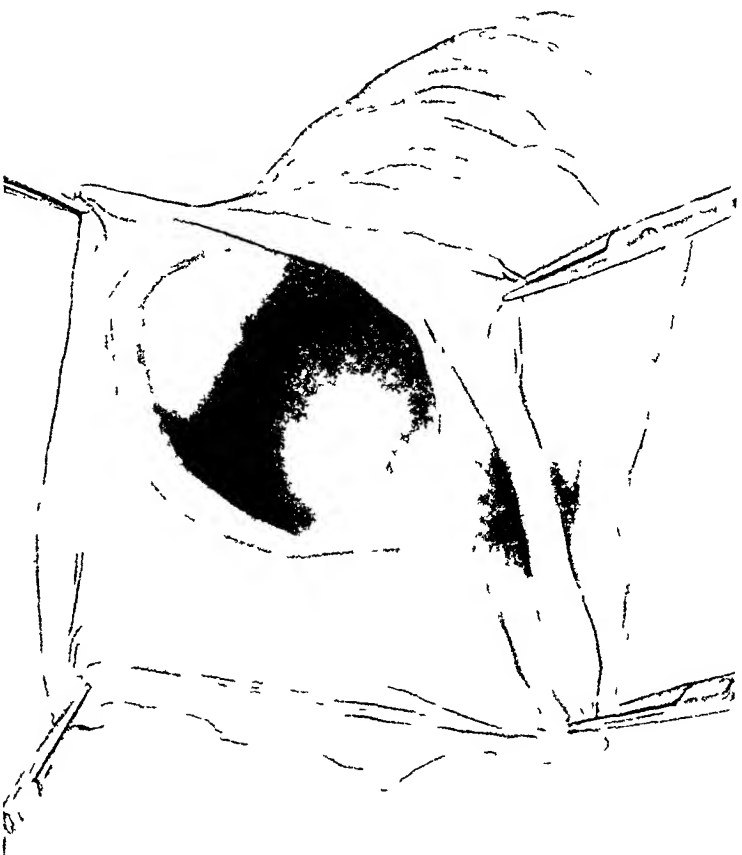


FIG 2—The sac of the femoral hernia with one to two inches of surrounding peritoneum reflected

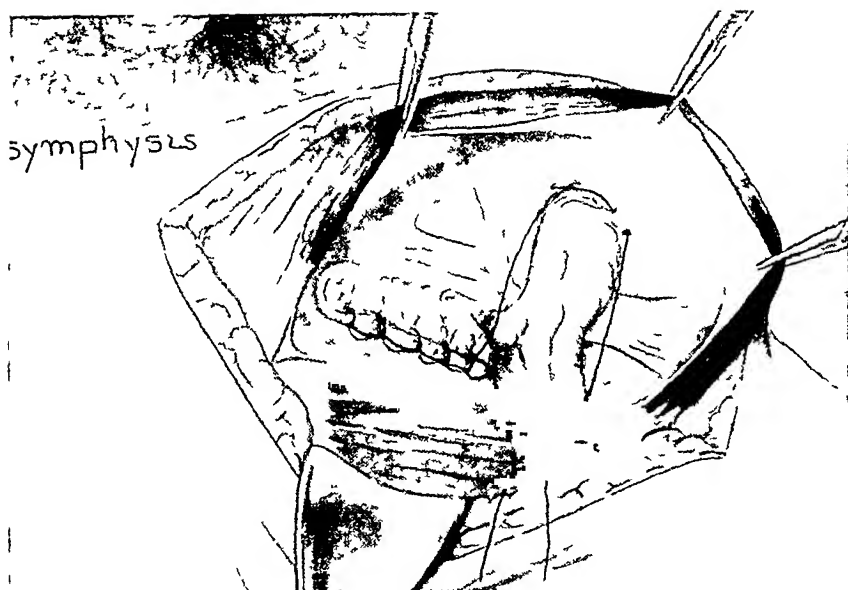


FIG 3—The sac and adjacent peritoneum has been removed, the cut edges of the peritoneum sutured and about to be tacked to the parietal peritoneum at the position of the internal inguinal ring and anterior abdominal wall. The femoral orifice and canal in this case easily admitting two fingers side by side was not closed.

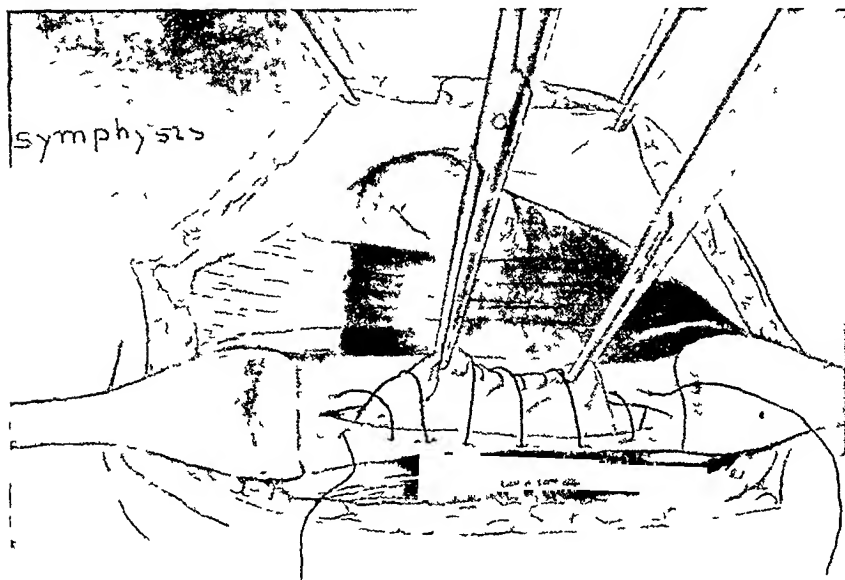


FIG 4—The sutured peritoneum from the region around the previous location of the neck of the hernia is now being sutured to the original incision of the peritoneum just above the inguinal ring. This suture passes through the stump of sutured peritoneum as it is held up by forceps. This does not appear to be the case in the drawing for the reason that in this particular case the sutures were passed through from the lower side.

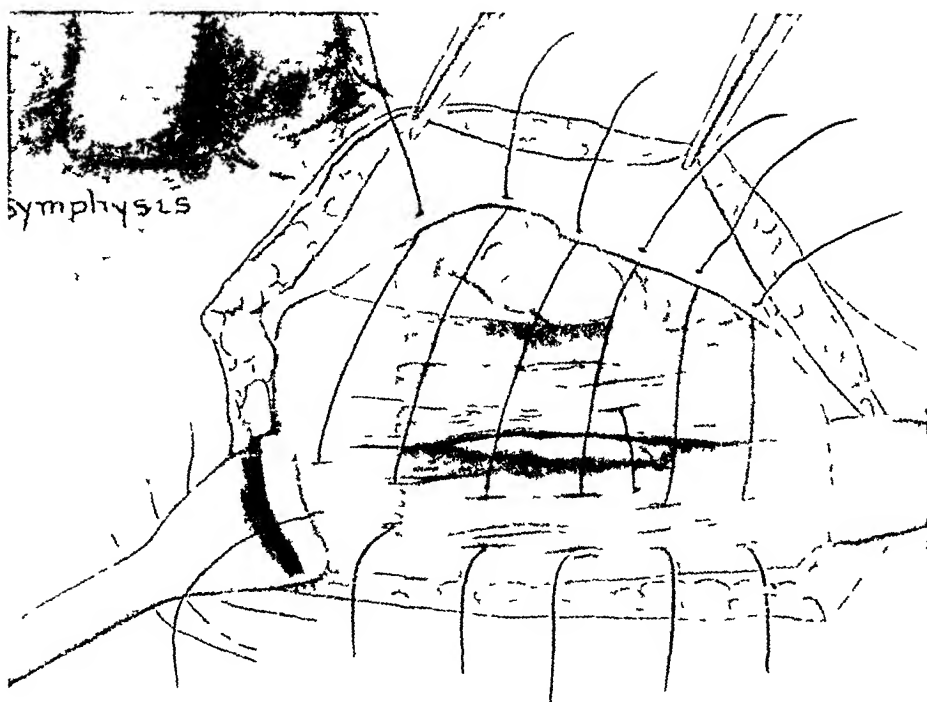


FIG 5—In the final closure of the split made in the internal oblique and transversalis muscles the lower end of the suture catches the under surface of Poupart's ligament. These sutures are very loosely tied and under no circumstances should they exert tension on the muscle fibres. To avoid atrophy of the little bundle of fibres on the lower side of the split these are not caught in the suture.

their approval of this method of approach to the sac in dealing with herniæ of large size with contents adherent and in other ways complicated and difficult to cure, and for operating on recurrent cases (cases in which at the first operation the sac had been incompletely removed) With their stamp of approval of the usefulness of the method for large, difficult and complicated cases, I am encouraged in the belief that the method is best suited for all cases No one has suggested that the intra-abdominal approach is difficult or dangerous From an experience of operating upon more than three hundred cases of all types of inguinal and femoral hernia by this method, I can testify that the sac and adjacent peritoneum is more easily and completely removed from within than from without, and after painstaking effort I am unable to find a single patient who subsequently developed hernia.

After complete removal of the sac and redundant peritoneum above its neck and the highest practicable suture of the cut edges of peritoneum, problems of "orifice closure" and "canal obliteration" are problems of wound closure This should be accomplished by the method which permits restoration nearest to anatomic and physiologic normalcy of the muscles and fascia stretched by the protruding hernia and cut and separated by the operative procedure

The method of Halsted, as described by his pupil, Taylor (*Archives of Surgery*, September, 1920), is a perfect application of the principles of biology to the form and function of the muscles involved in inguinal hernia and solves the problems referable to the repair of the abdominal wall in relation to the inguinal canal. Indeed certain other methods of "canal obliteration" are quite adequate for this accomplishment, and, provided the sac and adjacent peritoneum are completely removed and the wound heals without suppuration or tissue strangulation and atrophy, are followed by cure of hernia without subsequent bulging.

After removing femoral hernia there are many methods of orifice closure and canal obliteration, probably none of which are necessary (Ochsner), if all the sac and adjacent redundant peritoneum about its neck is removed

In curing umbilical hernia there is no canal to be closed The operation consists solely of removing the hernia with its orifice and closing the wound

The pictures here reproduced are the finished product of sketches made at the time of operation upon the case of femoral hernia herewith illustrated

The incision is made through the skin, superficial fascia and aponeurosis just above the location of the internal inguinal ring The fibres of the internal oblique and transversalis muscles and fascia are separated in the usual muscle-splitting fashion, making a good exposure of the peritoneum, this is then picked up and opened in the usual way. After retracting the edges of the wound, the neck of the hernia is adequately exposed from within the general peritoneal cavity Adherent omentum and bowel can be completely and easily removed and a thorough exploration of this region of the abdomen is easily made.

With the finger or a pair of blunt curved forceps in the hernial sac from above, enucleation aided externally by a gauze-covered finger or sharp dissection is easily accomplished and the femoral and other large vessels are quite safe from injury. The sac being freed is easily turned inside out into the peritoneal cavity. The sac and redundant peritoneum in the region are pulled well upward, clamped sufficiently high to take up all the redundant peritoneum and excised. In this way the entire sac and from one to two inches of the surrounding proximal peritoneum are removed. The cut edges of the peritoneum are then sutured. It has seemed advantageous to tack the sutured portion to the position of the internal inguinal ring and to the edges of the original incision in the peritoneum. This effects practically a transplantation of the peritoneum away from the region of the femoral orifice and brings the raw surface of sutured peritoneum out of contact with bowel and omentum. The split muscles are then loosely sutured and in a hernia of small size this is perhaps all that is necessary. I have, however, made it a plan in herniæ of large size to catch the under surface of the aponeurosis with sutures placed very loosely in the manner as if closing the inguinal canal. Great care should be exercised in tying them merely to hold structures without tension.

I have never made any effort to close either the femoral canal or the femoral orifice. In the patient here illustrated the femoral canal would admit two fingers side by side. We could feel nothing resembling Gimbernat's ligament. The patient here illustrated was operated upon in October, 1920, and recently has been thoroughly examined. There is no evidence of hernia. I have operated in this manner upon twelve cases of femoral hernia. All are cured, the first case over five years, the last case counted in this report, more than six months.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting Held October 12, 1921

The President, JOHN A. HARTWELL, in the Chair

CRANIOPLASTY FOR LARGE TEMPORAL DEFECT

DR DEWITT STETTEN presented a boy fifteen years of age, who four years ago, as a result of an automobile accident, sustained a severe depressed fracture of the skull in the right temporal region. A decompression trephining was performed at the time and apparently a considerable portion of skull was removed at the site of injury. The patient was left with a very large pulsating hernia of the brain, which after some time cicatrized and epithelialized. This protrusion gradually increased so that when the patient came under observation in February, 1921, it was the size of a large fist and covered by a broad, flat, glossy and thin scar, entirely denuded of hair. A photo of the boy taken in March, 1919 (Fig 1), gives some idea of the protrusion. The herniation, when the patient was first seen, was about half again as large as is shown in the picture.

Mentally, the boy was a trifle subnormal. He had no headaches or convulsions. There was a paralysis of the right frontalis muscle. The X-ray examination of the skull shows a bony defect involving almost the entire squamous portion of the temporal bone (Fig 2). The defect is irregularly circular in shape, with an average diameter of about 5 cm. The edges seem quite smooth and regular.

The chief complaint was that the protrusion interfered with the normal life of the patient. Its unsightliness was a constant source of embarrassment, and the fear of injury kept him from the usual activities of a boy of his age. It almost appeared as if the slight impairment in his psychical development was due more to these factors than to any organic cerebral injury or defect.

After a consultation with Dr. Joseph E. J. King, operative interference was decided upon.

On March 11, 1921, a preliminary scalp plastic was performed. The scar was excised by an elliptical incision. Hemorrhage was controlled easily by self-retaining retractors. A large cyst, filled with clear fluid, which represented a considerable part of the hernia, was opened. Its external wall was excised and the inner wall was cauterized with carbolic acid and alcohol. The edges of the cyst wall were sutured together. The scalp on either side was freed widely from the pericranium until the edges of the wound could be nicely approximated without tension, and the wound was closed. The wound healed

satisfactorily, leaving an almost linear scar and the protrusion was now insignificant

On April 7, 1921, the actual cranioplasty was undertaken. It was planned to use a free pericranial-cranial transplant utilizing the outer table of another part of the skull. This method was originally proposed by Schmieden and has been used with much success by King, Frazier and Coleman. Doctor King was good enough to assist at the operation and gave invaluable help and advice. Ether anæsthesia was used. The head was so draped by fixing the towels to the skin with a crown of towel clamps that both sides of the head could be brought into the aseptic field. The defect was then prepared. The scar was excised. The pericranium was incised 0.5 cm beyond the edges of the bony defect and the margins exposed. The dura was freed with a blunt separator. The hernia was reduced and oozing controlled by bridge sutures. The margins of the defect were freshened and all irregularities removed by beveling with an osteotome at a 45-degree angle. A linen pattern was cut and the outer side marked with a suture. The head was turned and through a straight incision over the left parietal eminence the pericranium was exposed and the pattern laid over it. The pericranium was incised around the pattern about 0.5 cm beyond its edge down to the skull. The protruding edge of pericranial flap was turned over on the pattern and the bone flap of the outer table was cut to correspond to the pattern. The circumference of the flap was first cut and then the osteotome was directed from the periphery toward the centre of the transplant. The edges of the transplant were beveled at about a 45-degree angle to correspond to the margins of the defect and the thickness of the bone was approximately 0.25 cm. This cutting of the bone flap is technically the most difficult part of the operation. The bone graft was somewhat chipped and broken, but in the main was still adherent to the pericranium. The free pericranial-cranial transplant was laid in the defect with the raw bony surface down, and pericranium sutured to pericranium. Both scalp wounds were carefully sutured, the angles being drained by small tubes, which were removed after forty-eight hours. In the short time allotted for this presentation one cannot cover every point in the technic of the operation, but for further details on the subject reference may be made to a recent publication of Doctors King and Anderson ("Cranioplasty: Indications, Operation and Results," *Southern Medical Journal*, 1920, xiii, 719-733).

The patient showed some evidence of shock after the operation, but quickly recovered. He vomited a good deal and had a moderate headache, probably because of the increased intracranial tension, but after two days these symptoms subsided. The wounds healed by primary union and the graft took, leaving a flat, smooth and solid skull where the defect had been. The X-ray taken one month after operation (Fig 3) shows the defect completely filled in with new bone, almost as dense as the rest of the skull. About two weeks after operation the patient had a rather severe headache for twenty-four hours, but since then there have been no headaches, convulsions or symptoms of any kind referable

Fig 1 —Photograph of patient taken in March 1919, showing cerebral hernia and scar



Fig 2 —X ray before operation showing temporal defect





FIG 3 —X ray taken one month after operation showing defect filled with new bone



FIG 4 —Photograph of patient taken in September 1921 five months after operation

to the head. One can now feel a slight groove anteriorly between the skull and transplant, but the solidity of the plastic has remained and hair has covered the major part of the scar, giving the head quite a normal appearance (Fig 4). The area from which the transplant was taken cannot be differentiated from the rest of the skull. The patient's mental condition seems improved, mainly because his unsightly and disabling deformity has been removed.

DR J P HOGUET reported a case somewhat like that of Doctor Stetten. The man had been through the war, came home, and was a welder. While doing acetylene welding the tank blew up and a piece of metal struck him in the left frontal region. He was taken to a Newark hospital, where it was said the bone was so extensively comminuted that nothing could be done except to take out a few fragments. It seemed that the first nerve endings had been cut, as he had no sensation of smell or taste. He consulted Doctor Hoguet on account of persistent headaches and a feeling of insecurity and wanted something done to give him relief. Doctor Hoguet operated on him in March, 1921. He cut through the old scar, and except for the exact underlying region where the scar was slightly adherent, it peeled off easily from the dura. He freshened the edges of the cleft with rongeurs and separated the pericranium, pushing it back a little beyond the edges of the cleft. He then made a pattern of the defect on a piece of muslin. Following this pattern he removed a graft from the antero-interior aspect of the tibia, the graft being from one-eighth to one-quarter of an inch in thickness. It fitted into the cleft fairly well, leaving a little gaping. He sutured the perostium of the graft which had been left a little wider than the graft to the pericranium around the defect. The graft soon became absolutely firm. He dressed the wound every day in order to observe the progress, and noticed that the first three or four days the graft could be moved up and down slightly. It rapidly became more and more solid until at the end of a week it appeared to be as firm as the rest of the skull. The headaches and feeling of insecurity completely disappeared.

DR CHARLES A ELSBERG said that he had had occasion to close quite a number of cranial defects by cranioplasty. He very rarely made a complete transplant. He usually enlarged the incision, chiseled off the outer table of the skull covered by periosteum, and either turned it around and fixed it in the defect or turned it down as a flap with the periosteum inside of the skull. This latter procedure is to be considered advisable when there is a defect in the dura, so as to prevent new-formed callus from irritating brain tissue. Doctor Elsberg stated that he also had been surprised at the remarkable rapidity with which these grafts of the outer table of the skull healed in place, so that within a few months very little abnormal could be seen in the X-ray picture.

DR JOSEPH E J KING said that the first cranioplasty he saw was in 1915 when he assisted Dr Hermann Fischer at a base hospital in Germany. That operation was performed according to the König-Müller method, that is,

by sliding an adjacent pedicle flap, consisting of the entire thickness of the scalp and portion of the outer table of the skull, over the defect, in so doing the bony portion of the flap was practically detached from the soft parts of the flap, the bony portion was placed in the defect and the flap sutured over it. In this case the bony portion took and the defect was corrected. After seeing the difficulty of removing the flap, he wondered why a complete pericranial osseous transplant would not do as well.

In 1916 he operated upon several cases and used such a transplant from the tibia. Later he visited Doctor Schmieden's clinic in Holland and found that they were using cranial grafts which were removed from the skull by an extension of the incision when possible. This type of operation was used in the neuro-surgical services at Cape May and Fox Hills by Doctor Frazier, Doctor Coleman and himself. The graft was placed with the bony side downward, they did not turn the graft upside down as Doctor Elsberg did. Doctor Bagley, at Fort McHenry, operated upon his cases and reversed the graft in the manner spoken of by Doctor Elsberg. The results reported were about the same as when the graft was not reversed. It seemed that it made but little difference in the result whether the defect was closed by the one or the other of these methods.

Doctor King said he felt that a word should be said in regard to the contra-indication to cranioplasty. A cranioplasty should not be done in the presence of sepsis. One should wait at least three months after absolute healing had taken place, and in some instances this is not sufficient length of time. In some cases one should wait six months or a year. In those cases in which a foreign body was retained, the defect should not be closed until the foreign body had been removed. Those cases, in which the brain had been penetrated and a tract had been left, should not be closed. The ideal case for cranioplasty was the deep fracture where there was no laceration of the brain tissue and where the patient was practically symptomless, with the exception that he had a hole in his head. Both Doctor Elsberg and Doctor Hoguet had spoken of the rapidity with which the graft healed in the defect. These grafts really seem to cement themselves into the defect and form a solid closure. Doctor King said they had had about eighty-four such cases and he had seen but one instance in which the graft was absorbed. In that case the patient had post-operative pneumonia followed by a right-sided empyema, due to the hæmolytic streptococcus. The graft had become absorbed after about four months, leaving the defect exactly as it was before the operation was done. A second cranioplasty was performed by this time under local anæsthesia. This graft healed in, and remained as long as the patient was observed in the hospital, a period of about three months.

Doctor King expressed the opinion that it was preferable to use a transplant from the head. It was more convenient and there was but one incision necessary in a number of cases. In cases where there is a frontal defect it will be necessary to make two incisions, a second one over the parietal eminence for the removal of the graft. In such a case it would not be advisable

INOPERABLE CARCINOMA OF BREAST

to extend the incision over the posterior part of the skull. If the defect was a long narrow one it was better to use a tibial graft. So far as the results were concerned he had noticed no difference between the cranial and tibial grafts.

INOPERABLE CARCINOMA OF BREAST UNUSUAL RECENT RESULT FOLLOWING X-RAY RADIATION

DR BURTON J LEE presented a woman thirty-one years of age, who first was admitted to the Memorial Hospital on March 7, 1921, with a very unusual type of breast carcinoma. She had had one child, seven years of age. In November, 1918, an ulcer appeared on her upper lip, which remained unhealed for four months. A positive Wassermann was obtained. The patient was treated with hypodermic injections of mercury for a period of one year. Shortly after the beginning of treatment she began to show scaly areas upon the hands and pigmented spots over the surface of the body, which were presumably luetic. All of these symptoms subsided completely under treatment. In June, 1920, she noticed a tender swelling of the right breast, situated in its upper, inner portion. This proved to be an abscess, which was incised and soon healed.

In August, 1920, a reddish, raised area appeared over the upper, inner portion of the right breast. This gradually spread until it involved the skin over the major portion of the right breast, running somewhat over to the left. Posteriorly it had extended well around to her axilla. Her chief complaints upon admission were pain in the right breast, the presence of a mass in her right axilla and a general feeling of malaise. She seemed fairly well nourished and was of sallow complexion. Both breasts were very full and heavy and quite indurated. Both were movable on the deeper parts. The skin over the right breast was a brilliant red and contained numerous small elevated areas that looked almost vesiculated. This reddened area extended well up toward the right clavicle, over as far as to the nipple line of the left breast and to the right as far as the midaxillary line. Inferiorly it reached the rib margin.

In some places the line of demarcation between this reddened area and normal skin was quite distinct. In others it merged gradually into normal skin. The measurement horizontally of this whole reddened area was 52 cm—vertically 38 cm. In both axillæ there were large, hard, movable nodes. In the right side of the neck there was also a chain of nodes extending two-thirds of the distance from the clavicle to the mastoid. The left supraclavicular region showed no involvement of nodes. There was a scar of the lesion mentioned, in the past history, over the upper lip.

The patient was treated entirely by X-ray radiation by Doctor Herrendeen, the radiologist of the Memorial Hospital, the first treatment being given on March 7, 1921, with a six-minute time exposure; a current of 5 milliamperes, a filtration of 4 millimetres of aluminum, using a 9-inch spark gap and a 10-inch focal distance. Treatment given over the right breast anteriorly and laterally.

At two-day intervals the supraclavicular and axillary regions were similarly treated

Beginning April 6, 1921, a second cycle was given, being confined entirely to the involved skin area. Time exposure was four and a half minutes, with a current of 7 milliamperes, a filtration of 3 millimetres of aluminum, using an 8-inch spark gap and an 8-inch focal distance.

Four additional treatments have been administered—one on June 24, 1921—time exposure being 12 minutes, current of 4 milliamperes, filtration—3 mm of aluminum, 10-inch spark gap, and 12-inch focal distance. Three other similar treatments were also given on July 15th, August 8th and September 6, 1921, save that the time exposure was for fifteen minutes.

A section removed from the reddened area over the upper mesial portion of the lesion was pronounced by Doctor Ewing to be "mammary cancer invading the lymphatics of the derma." Nothing in the pathological examination suggested a syphilitic element in the lesion.

Doctor Ewing's pathological report on the case was as follows: "Sections of the skin and subcutaneous tissue reveal a cellular carcinoma invading the lymphatics just beneath the epidermis, about the hair and sebaceous follicles, and about the blood-vessels of derma and subcutaneous tissue. These lymphatics are everywhere filled and often distended with masses of large polyhedral cells with hyperchromatic nuclei. They resemble the cells of mammary duct carcinoma. About the lymphatics there are many lymphocytes, some of which are also found lying among the tumor cells. There is considerable congestion of small blood-vessels and much oedema, but no definite hemorrhages can be seen. The epidermis is thin and scaly but otherwise unaltered. The endothelial cells of the invaded lymphatics appear unchanged."

A radiograph of the chest made by Doctor Herrendeen on March 7, 1921, showed no definite evidence of carcinoma. A second plate made June 6, 1921, revealed evidence suggesting carcinomatous metastases. No further plate has been made to date.

A Wassermann reaction—April 4, 1921,—gave a two plus result.

The last note made upon the patient was on September 12, 1921. Whereas her weight upon admission was 134½ pounds, it was 158½ pounds on this date. There was a marked disappearance of the superficial lesions, but there were still three small superficial masses attached to the upper, lower and outer portions of the right breast. The right breast itself seemed heavy, but no distinct tumor could be made out of it. The left breast also seemed firmer than normal.

In the right axilla there was a mass of nodes, and there was a similar mass in the left axilla.

The patient was shown as a very unusual type of primary inoperable mammary carcinoma and to illustrate also the marked regression possible in a superficial lesion treated by proper X-ray radiation.

Doctor Lee believed that the patient would finally probably succumb to her disease, but felt that the treatment by X-ray radiation had certainly given a very interesting palliative result to date and had undoubtedly helped to prolong the life of the patient.

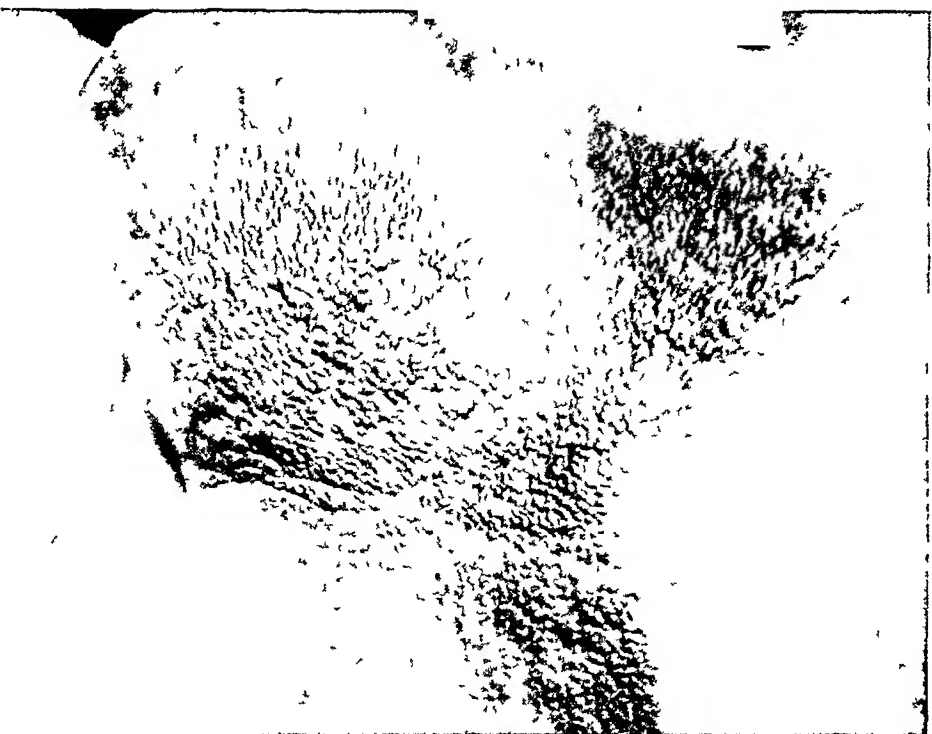


FIG. 5.—Dr. Lee's case of carcinoma of breast, original type of treatment, March 7, 1921



FIG. 6.—Results in four months after beginning of treatment

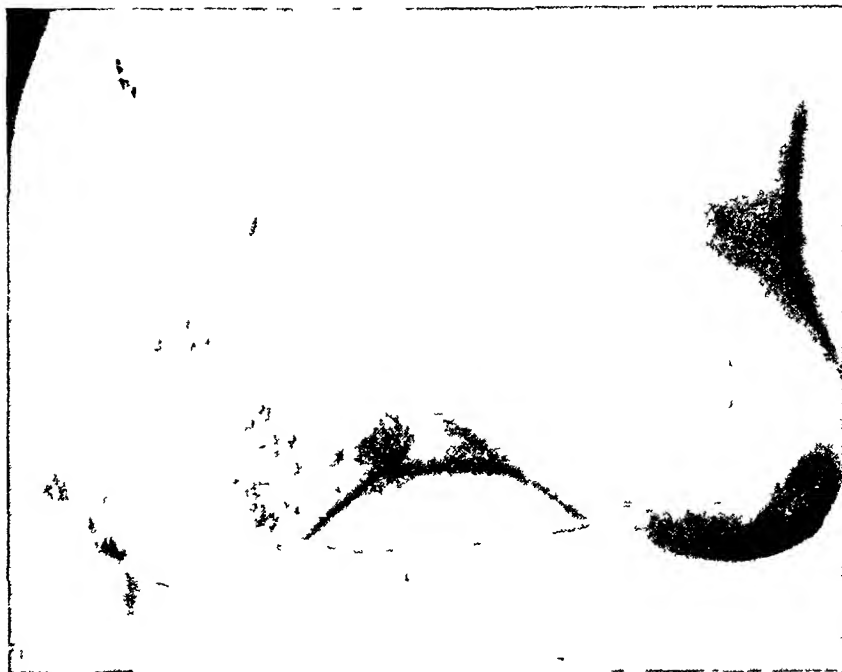


FIG 7—Results six months after beginning of treatment



FIG 8—Microphotograph from Dr Lee's case of inoperable carcinoma of the breast

BRANCHIAL FISTULA

DOCTOR LEE said that the patient represented a rather unusual type of carcinoma. They had, however, seen four or five cases of the pseudo-inflammatory type of breast cancer, but here there was a diffuse redness and a blush over the large area of skin involved. He had never seen quite this picture. So far as the type of carcinoma was concerned, it certainly was not an adenocarcinoma. The disease was rapidly infiltrating, was very cellular and had spread rapidly into all areas. So far as removing a section from the breast itself was concerned, the patient had been unwilling to allow incision into the gland. He believed she would soon consent to the removal of one of the axillary nodes which would probably furnish additional pathological data. She had received no anti-leucic treatment since her admission to the clinic, though she had been treated before the appearance of the breast lesion.

Doctor Lee stated that they had seen a number of cases of carcinoma that responded readily to X-ray treatment, but most of them soon showed a reappearance of the lesion, and the process went on at the same rate as before treatment or sometimes more rapidly. He would be glad to report on this case later. He thought it was proper to criticize the diagnosis of breast carcinoma without a section from the breast itself, though he believed there was little doubt that that was what the patient had.

BRANCHIAL FISTULA

DR HOWARD LILIENTHAL presented a man twenty-six years old, who entered Mount Sinai Hospital May 5, 1920. His tonsils were said to have been removed in June, 1919, but tonsillar tissue was still present. The patient had a congenital discharging sinus over the lower part of the anterior portion of the sternomastoid muscle. The discharge was sometimes mucoid and again purulent. A fine probe passed upward through this tiny orifice for four or five inches and the probing excited reflex cough. There were palpable lymphnodes on both sides of the neck and in the axillæ and inguinal regions.

On May 6, 1920, Doctor Lilienthal operated, general anæsthesia preceding the operation by an injection of concentrated solution of methylene blue into the sinus. None of the dye appeared in the patient's mouth. He incised the skin around the little orifice so as to mobilize the fistula. Traction upon the mobilized part made it possible to palpate through the skin a cordlike mass running upward and slightly backward. The incision was carried from the fistula upward and backward to the angle of the jaw and the fistulous structure was easily followed to this point where it appeared to widen and to proceed toward the pharynx. It was covered throughout with longitudinal muscle fibres which contracted actively on deglutition, drawing the entire mobilized cyst upward with a cremaster-like action. This muscle was now dissected off and methylene blue was injected into the higher part of the canal with a hypodermic syringe. The dye appeared immediately in the mouth behind the right tonsil. Through an incision in the wall of

the tract he easily passed a filiform bougie into the patient's mouth and tying a piece of strong silk to the buccal end of the bougie he drew it out through the wound in the neck, leaving a long piece protruding through the mouth. The external end of the silk was then tied firmly around the wall of the sinus at the fistula and drawing upon the end which protruded from the mouth he was able to invert the entire tract and to cut it off, leaving a very short stump close to the mouth. The external wound was closed with drainage by means of a small-calibre tube which reached from below to the pharyngeal wall.

Healing was rapid and when the patient was seen on June 25th was complete. Strong pressure behind the angle of the jaw would cause the appearance of a minute opaque bead in the mouth. The patient is now entirely well. There is no discharge anywhere, but in the mouth behind the right tonsil, a minute papilla marks the location of the oral aperture of the sinus.

DR FRANK S MATHEWS stated that there are described a number of dissections of fistulas of the second branchial cleft which have shown that the fistula passes between the external carotid artery in contact with the internal jugular vein and pneumogastric nerve before entering the wall of the pharynx. The close relations of these important structures add greatly to the difficulties of dissection and show the wisdom of employing the method recommended by Doctor Lilienthal.

DR SEWARD ERDMAN said Doctor Lilienthal had spoken of the branchial cyst in this case opening into the pharynx. He had recently seen a thyroglossal cyst which opened into the pharynx. Thyroglossal cysts were not uncommon. This one occurred in a young girl. It was egg-shaped and lay between the thyroid and the hyoid bone. It was red, tender and swollen. After pressure on the cyst the girl said she felt a discharge come into her mouth. On examination it was found that pus welled up at the base of the tongue. Doctor Erdman said this was the first time he had been able to demonstrate a patency of the thyroglossal duct, through the foramen cæcum of the tongue.

DOCTOR LILIENTHAL, in closing the discussion, said that this fistula must have gone in the direction Doctor Mathews mentioned. In dissecting he had kept pretty close to the muscle covering the structure. He did not go to the end of the tract because he thought the dissection would become more and more tedious and troublesome, so he tried to invert it into the mouth to avoid this. Thyroglossal fistulæ were much simpler so far as the actual dissection goes than branchial cysts because one is less likely to strike any important structure. Doctor Lilienthal said he had had a number of these cases, but this was the only one that had come to him first, all the others had come to him after others had treated them and after there had been infection. The branchial fistulæ were more difficult to get out than the thyroglossal because they were apt to have ramifications which made the problem of their removal more serious.

SPLENECTOMY FOR PERNICIOUS ANÆMIA

SPLENECTOMY FOR PERNICIOUS ANÆMIA

DR J M HITZROT reported the case of a woman, aged thirty-six, who was admitted to Doctor Connor's service, New York Hospital, September 25, 1920, complaining of weakness, numbness, throbbing in head, stomach trouble. Present trouble began five months ago with feeling of weakness, belching of gas and swelling of the ankles. Her appetite became very poor. Condition has increased steadily up to her admission. Menses negative—normal. Important points on physical examination were lemon color of skin, general anæmia. Teeth gone. Heart—soft systolic murmur at apex. Lungs negative. Abdomen negative except for small umbilical hernia. Spleen was considered palpable by some members of the staff and not by others. Pelvic negative. Hæmoglobin, 30, red blood-cells, 1,000,000, white blood-cells, 1300, polymorphonuclears, 41 per cent, lymphocytes, 47 per cent; eosinophiles, 2 per cent. Occasional normoblast. No increase in blood platelets.

Stomach. Total acid 1.6, free HCl 0.8. Lactic acid negative. Guaiac tests negative.

Fluoroscopic (Doctor Holland). Heart, liver and œsophagus negative. Stomach orthotonic, hooked, good position. No defects or spasm. Negative for organic change.

Stool examination negative for parasites or ova.

September 28, 1920. Transfusion 350 c c blood, chill.

October 8, 1920. Transfusion (from another donor) 400 c c blood, no reaction.

October 24, 1920. 300 c c from first donor; same reaction.

November 5, 1920. Transferred to First Surgical Division.

November 8, 1920. Operation, splenectomy. Spleen three times normal size. Perihepatitis. Gall-bladder thick walled, containing stones, removed between clamps. Small subserous fibroid in uterus. Appendix normal, not removed.

Discharged eighteenth post-operative day, hæmoglobin 55 per cent, red blood-cells, 3,000,000.

Culture from gall-bladder sterile.

Condition has remained stationary since then.

Blood, October 3rd. Hæmoglobin, 45 per cent, red blood-cells, 2,500,000. Numerous normoblasts. The symptoms existing before

DOCTOR LILIENTHAL said that he had done a number of splenectomies, although only one in a case of pernicious anæmia. That patient died of morphine poisoning after the operation.

Doctor Lilienthal asked Doctor Hitzrot what type of blood transfusion he employed. He said he asked this particularly because of the chill that so often followed transfusion by the citrate method, the reply being made that the citrate method was used.

DOCTOR LILIENTHAL expressed the opinion that in primary blood disease it was better not to use the citrate method but to use whole blood. He said he had formerly used the citrate method following pulmonary lobectomy. He formerly did a blood transfusion after lobectomy because there was a

huge outpour of bloody serum into the pleura for the next forty-eight hours following the operation. It was equivalent to the loss of a large amount of blood because the fluid contained as much as 10 per cent hæmoglobin. That loss had to be replaced, so he had used blood soon after the operation. He had had two cases in which death occurred with a terrific rise in temperature after transfusion immediately following lobectomy. There always seemed to be more or less reaction following transfusion by the citrate method after lobectomy, so he had given up all except the direct methods. He preferred one of the syringe methods which had less danger of reaction than the citrate method. Whether the citrate method acted as well as whole blood in primary anæmia he was not enough of a hæmatologist to say, but he would like to hear what others had to say on that point.

DR FRANZ TOREK said it would be encouraging to hear of a case of pernicious anæmia successfully treated by splenectomy. In the case reported he did not hear any mention of the presence of megalocytes or megaloblasts in the blood. To his understanding a case of anæmia could not be diagnosed as pernicious anæmia unless the blood contained megalocytes and megaloblasts. Doctor Torek reported a case of his own of pernicious anæmia in which he performed splenectomy. The patient was a Russian, twenty-seven years of age, ill for three years with the characteristic clinical symptoms of pernicious anæmia. When he came to the hospital his blood count was hæmoglobin 40 per cent, red blood-cells 1,900,000, white blood-cells 2400. Megalocytes and megaloblasts were present. The patient had all the characteristic symptoms, a sallow yellow appearance, such general symptoms as weakness, loss of appetite, loss of weight, constipation, headaches, dyspnœa, slight œdema, polyuria, blood in the urine and blood in the stools. The stools were examined and no bothriocephalus ova were present. The patient was transferred from the medical department to Doctor Torek's service. He operated on him on October 2, 1920. He had a very normal post-operative course. After about two weeks his wound was completely healed and he was retransferred to the medical service. While in the surgical division blood studies had been made practically every day, and later quite frequently until he was discharged after the medical division had studied him about a month longer. When he was discharged he felt distinctly better, though the blood examination showed no improvement whatever, either as to the degree of the anæmia, the number of red cells remaining as low as before, nor as to the kind of anæmia, for he still had megalocytes and megaloblasts. He went out and took a job which required about two hours of work daily. Doctor Torek mentioned this because before his admission to the hospital he had been unable to work for two and a half years. Three months later he returned to the hospital. His blood count was then 10 per cent of normal. His symptoms were mostly gastric. He died about eight days after admission. The autopsy showed a hypertrophied heart, parenchymatous nephritis and the cause of death was pernicious anæmia. The appearance of improvement was probably nothing more than one of the remissions one sees in cases

SPLENECTOMY FOR PERNICIOUS ANÆMIA

of pernicious anæmia without treatment Sometimes remissions last quite a long time whether the patient is treated by splenectomy and transfusion or not

Doctor Torek added that the incision he had used in doing the splenectomy was one he had devised but had never published It began at the ensiform cartilage, ran along the left costal border and extended to the posterior axillary line or still further back The front part of the incision passed outward and downward and the back part ascended again This incision permitted raising the costal arch, giving good access to diaphragmatic adhesions and bands It was a combination of the anterior costal incision and the oblique lumbar nephrectomy incision It had one drawback in that more blood-vessels had to be secured than with the rectus incision, but this was more than counterbalanced by the greater ease with which one could handle adhesions and the greater access to the entire region Where the spleen was movable the ordinary rectus incision was satisfactory

DR RICHARD LEWISOHN stated that they had had occasion to test the different methods of blood transfusion in pernicious anæmia, using citrated and uncitrated blood, and they had found that it was really not the method which played any rôle in the effectiveness of transfusion, but it was the time at which it was done In the early stage any method would be effective, but if one got a case of pernicious anæmia in the late stage no method would be of great benefit Doctor Lilienthal mentioned chills following citrate transfusion. There was no doubt that among the citrate cases a larger percentage had chills than among the non-citrate cases, the percentage in which chills occurred being twenty-five in the citrate cases against five in the non-citrate cases, but no method of blood transfusion was free from chills Doctor Neuhoof, who administered 6 to 8 grams of sodium citrate intravenously for the prevention of hemorrhage, did not observe one chill among 100 cases The real cause of the chills still remains unknown

CORRESPONDENCE

FRACTURE OF THE METATARSAL BONES—BLOODLESS REDUCTION

EDITOR OF ANNALS OF SURGERY

SIR.

IN the ANNALS OF SURGERY, August, 1921, page 214, there is an article on "Fracture of the Metatarsal Bones," with a report of four cases. These fractures were all reduced by open operation, and in only two cases, according to the histories, "an attempt was made to reduce the fractures and dislocations under ether anæsthesia without success." In conclusion the author writes "If there be deformity sufficient to markedly destroy the convexity of the bones, especially if more than one bone is broken, or the fracture includes the second and third metatarsal bones, then open operation should be considered."

I saw in consultation recently a case quite similar to Case IV of the above series. This patient's left foot was run over by a motor car. X-ray (Fig 1) revealed comminuted fracture of the second, third and fourth metatarsal necks, with plantar displacement and shortening of the distal fragments also, fracture-luxation at the fifth metatarso-phalangeal joint, fracture of base of first metatarsal, and of outer sesamoid. It will be noted that the second toe rides between metatarsals two and three, the third toe rides on metatarsal four, while the fourth toe rides between metatarsals four and five, the fifth toe being displaced lateral to its metatarsal head. These displacements are practically identical with those in Case IV and are what one would expect, given a vulnerating force acting from the lateral to the mesial border of the foot and compressing the arched metatarsals proximally and the flat toes distally. The following then must be the mechanism of reduction in these cases. With both thumbs applied to the plantar surface just behind the displaced metatarsal heads, the latter are shoved vigorously forward and inward, an assistant at the same time exerting traction upon the toes in the same directions. Then, while the assistant maintains his hold on the toes, the metatarsal shafts are spread by plantar manipulations aided by dorsal pressure. This mechanism is one by which the deformity is virtually "untwisted."

Accordingly, under nitrous-oxide-ether, with the assistance of Dr S R Skillern, Jr, this plan was carried out, with the result shown in the skiagram (Fig 2)—again similar to that of Case IV of the above series, but in which the open method was employed.

I therefore submit this method as the one of choice, especially in those cases—as in mine—where there are constitutional contra-indications to open operation.

Respectfully yours,

P G SKILLERN, JR

BOOK REVIEWS

EPHRAIM McDOWELL, FATHER OF OVARIOTOMY AND FOUNDER OF ABDOMINAL SURGERY With an Appendix on JANE TODD CRAWFORD BY AUGUST SCHACHNER, M.D. Cloth, 8vo, p 331. Philadelphia, J. B. Lippincott Co., 1921

Here is a book with a mission which the author has approached with all the zeal of an enthusiast and all the enthusiasm of a zealot. Fortunate is the man whose memory finds such a recorder to preserve it. Perhaps the most interesting and not the least important pages of this volume are those which present the attitude of the leaders in surgery in McDowell's time and for a generation thereafter, toward surgical attacks upon ovarian tumors. The reaction of the two Hunters to the problem is significant of all. In 1757 William wrote that he had seen a great number of encysted dropsies of the ovary and yet had never seen one cured. From his observations both in the living and the dead body he pronounced the disease to be incurable and expressed the opinion that a patient thus afflicted could have the best chance of living longest who does the least to get rid of it! His brother John, however, went a step farther in 1785 when he said that "he could not see any reason why, when the disease could be ascertained in an early stage, surgeons should not make an opening into the abdomen and extract the cyst. The merely making an opening into the abdomen is not highly dangerous." But, the more's the pity, John Hunter never did this reasonable and, in his opinion, not highly dangerous thing, notwithstanding according to the testimony of his brother the cases demanding it were to be seen in great numbers around him.

The possibilities of such operations remained an academic question until subjected to the test of an experiment made by a thoughtful, resourceful, self-reliant man in a frontier town of an American settlement!

The French School of Surgery, then the most dominant surgical influence in Europe, was even more positive in denouncing any intraperitoneal efforts than was that of Great Britain, and it was not until fifty years after the great and successful experiment of McDowell that the surgeons of Paris were willing to admit an ovariectomy to be a justifiable operation.

McDowell had undoubtedly become familiar with the academic side of the ovarian tumor question during his Edinburgh years. We can imagine his mental processes as he listened to the discussions of the subject by John Bell, and his quiet firm resolution that after he got back to his own land no case of the kind would be turned away from his door without the offer from him to make trial of the only possible means of relief. So when in December, 1809, Mrs. Crawford rode up to that door, he was ready for the experiment. But what shall be said of the woman? Her surgeon to raise her courage and hope, could not point to any record of successful attempts in similar cases either by others or by himself. He could but inform her of her dangerous situation and propose to her a procedure for her possible help which he was willing to make but which he had to confess was purely an experiment. The courage,

fortitude and determination of the woman was equal to the test. Success crowned the effort—not only were many years added to her own life, but she had been the means of demonstrating to an incredulous world the possibility of help to a fatal condition hitherto considered incurable. She was the first of an endless procession of women in whom hopeless suffering was to be relieved and to whom countless years of active life were to be added. The fullness of time for the advent of this ray of light to womankind had indeed come. It was Mrs. Crawford's happy lot to be the blessed agent of this new boon to humanity. All things conspired to make the experiment a success. Had it been otherwise we probably should never have heard of McDowell. As it was the operator, encouraged by the successful issue of the experiment, but not unduly elated by it, proceeded in after years to repeat his work in other cases and so remove it from the domain of experiment to that of demonstrated fact. After the completion of the third case with in all an equally happy issue, he made public his experience in 1817, by a contribution to the *Eclectic Repertory*, vol. vii, page 242, of Philadelphia, and by a memoir sent to his old Edinburgh teacher John Bell. In a letter written in 1829 about one year before his death, he says that in addition to his first case he had up to that time operated eleven times, with one death. Thus it must be admitted that McDowell's work was neither accidental nor sporadic. It was a thoroughly thought out, well matured procedure without precedent, but yet not without reason. It was the first intentional, systematic invasion of the peritoneal cavity to gain access to and to remove a diseased organ. There was nothing pyrotechnical about McDowell. He was modest, unassuming, thorough, but self-reliant and positive, quick to let action wait upon conviction. He was in a high degree the special product of ancestry and environment. The coming generations cannot do him too much honor, and among womankind especially should his name be revered.

In this delightful book of Schachner's, from every possible viewpoint the career of McDowell is presented with much fullness. The author has produced more than biographies of the two great actors in this drama of the first ovariectomy. He has given us a critical study of the man and his time.

He has also greatly added to our knowledge of the other actor in this drama, Mrs. Crawford, tracing her to the date of her death at the age of 78 years, and her burial in a remote and obscure cemetery in Indiana.

True to the genuine spirit of his own State, he has not failed to magnify the peculiar position which Kentucky occupied in the early advance of the frontier of civilization beyond the Atlantic seaboard and to give a clear outline of the special influences, molding character, in which the hero of his worship grew up.

We thank Schachner for this work. It is evident that great labor and time and expense have been given to its compilation, with the result of the production of a book of the greatest historical value.

LEWIS S. PILCHER

BOOK REVIEWS

THE SURGICAL EXPOSURE OF THE DEEP-SEATED BLOOD VESSELS By J FIOLE, M D , and J DELMAS, M D Translated and edited by CHARLES GREENE CUMSTON, M D , 8vo cloth, p 87 London, William Heineman, 1921

This work is devoted to the description of procedures for freely exposing injured blood-vessels, in order that the pathologic conditions existing may be clearly seen and properly dealt with These procedures have been suggested by war conditions and belong more especially to the domain of Military Surgery The authors admit that the ligation of arteries in healthy tissues should still be carried out through the limited incisions that have become classic and are commonly described in all text-books of Operative Surgery The case is altogether different, however, when the surgeon has to do with an injured vessel complicating a gunshot wound, when a diffuse hæmatoma or a focus of lacerated and disorganized tissue is the area in which a vessel is to be sought for, its damaged walls are to be recognized, and as much of it as possible to be saved in order not to unnecessarily compromise the vitality of the tissues which depend upon it for their vascular supply A full and abundant exposure of the whole region involved alone can satisfy the requirements of such cases Perfect and constant visual control over the field of operation is essential for safe and good work

As one reads this plea for a change in methods of surgical effort in vascular surgery, one realizes that it is quite in harmony with the tendency of all surgery at the present time to abandon blind methods, to uncover every lesion by generous and free superficial incisions The more deeply seated the condition to be dealt with, the more liberal the approach to be provided so that adequate exposure be secured for the performance of safe and certain surgery

The recommendations of this book therefore are perfectly consistent with the best general surgery The larger vessels of the limbs and of the neck are in succession dealt with The illustrations are well designed The descriptions are concise and clear The translator has done his work well

LEWIS S PILCHER

MODERN ITALIAN SURGERY AND OLD UNIVERSITIES OF ITALY By PAOLO DE VECCHI, M D 8vo Cloth, pages 249, illustrated New York, Paul B Hoeber, 1921

This is an attractive book which cannot fail to command the interest of every surgeon whose horizon extends beyond his own parish The modern surgeon has been as a matter of course thoroughly acquainted with the work of the Germans and the French and the English The author with pardonable national pride is of the opinion that Italy has been sadly neglected and her share in the world's efforts toward further advancement in every branch of study, has not been recognized if indeed it has not been almost ignored He calls attention to the fact that the recent World War has not only been a revelation of a new Italy to many foreign nations but has been a revelation

BOOK REVIEWS

to herself. Italians of different provinces, heretofore unknown to each other, have been brought together to their mutual advantage and a better appreciation of the scientific value of the work done by their own countrymen. The object of the author therefore in this book is to familiarize American surgeons with the Italian School of Surgery, prompting them to visit Italy not only as a pleasure resort or a centre of antiquities but as a new seat of education.

The book opens with a rapid sketch of the creation of modern Italy, then takes up various phases of different military surgery in Italy, and then goes on more in detail to speak of the work and progress of the surgeons to be found at the present day in the various university centres of the country. The book is well worth the attention of every surgeon who desires to keep familiar with surgery's progress everywhere.

LEWIS S. PILCHER

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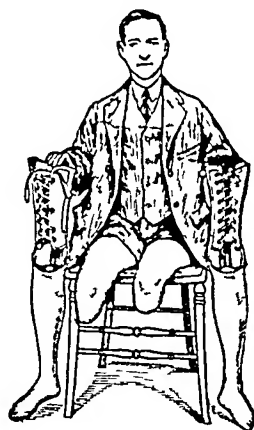
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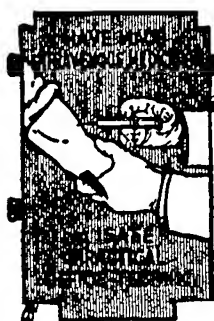
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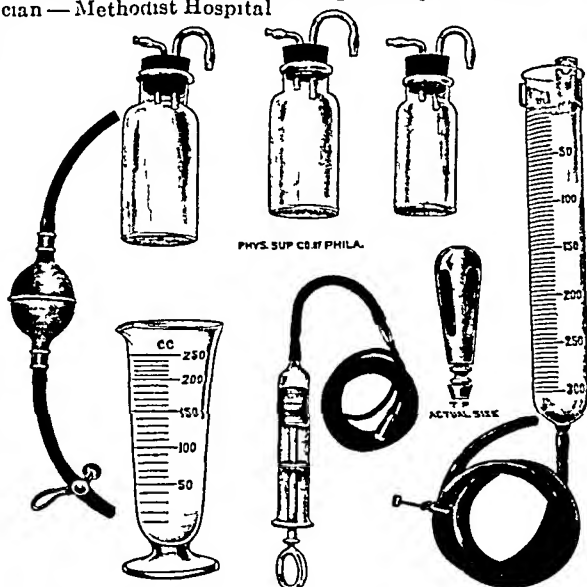
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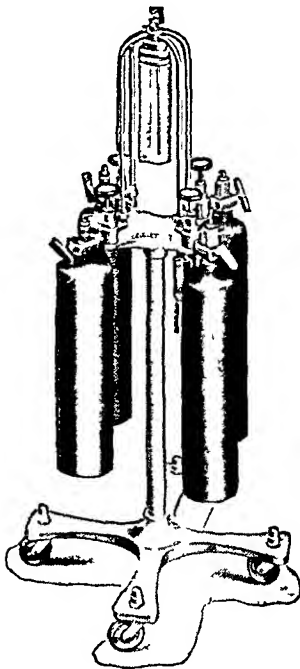
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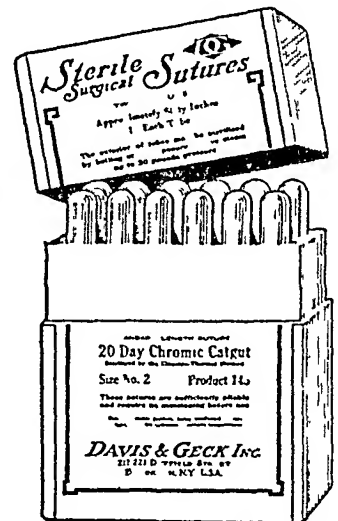
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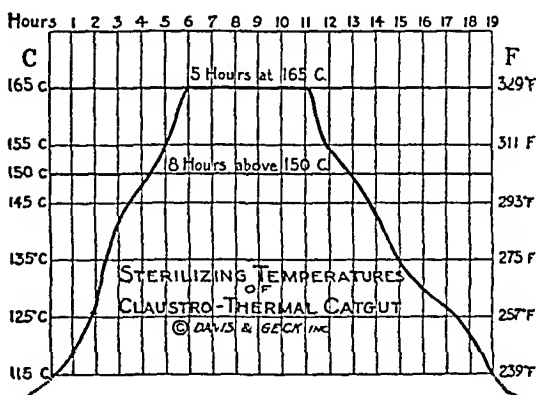
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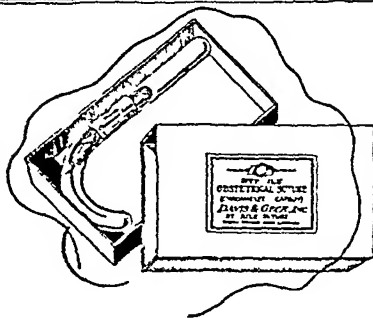
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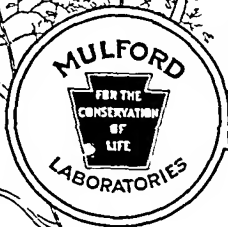
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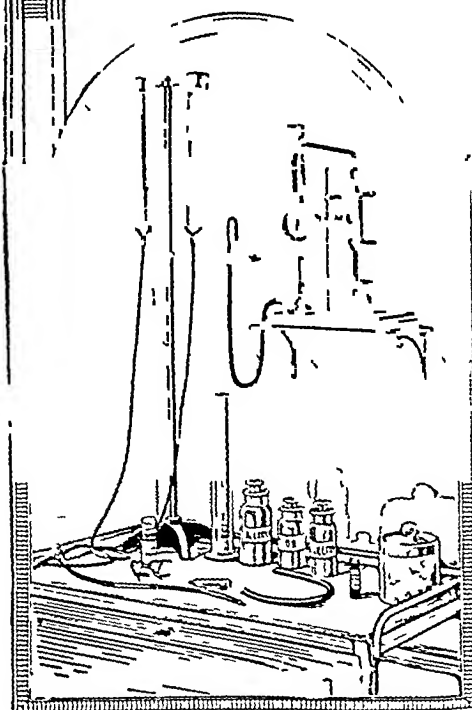
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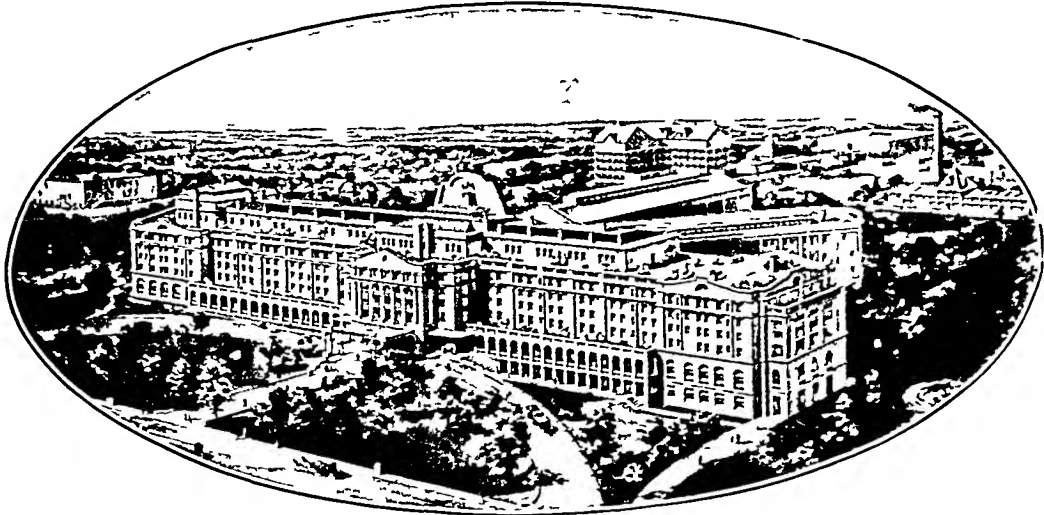


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MALIGNANT TUMORS OF THE THYROID

By LOUIS B WILSON, M D

OF ROCHESTER, MINNESOTA

Introduction —Correct early diagnoses of malignant tumors of the thyroid are made probably less frequently than of malignant tumors involving any other organ of the body. This results in treatment being deferred in most cases until it is useless. The mortality, therefore, is very high, although the incidence of the disease is less than of malignant disease of many other organs. This low incidence, however, is probably more apparent than real and is at least partially due to the failure in many cases to recognize the presence of the disease in either the living or the dead, since the symptoms are frequently not referable to the thyroid itself, and since post-mortems are altogether too rare.

The object in this paper is to call the attention of internists, surgeons, and pathologists to the unappreciated relative frequency of the malignant tumors of the thyroid, to summarize the principal observations in a pathologic study of the cases which have been observed in the Mayo Clinic from January 1, 1901 to January 1, 1921, and to present for convenience of reference a bibliography covering the subject during the last fourteen years.

Review of Literature —In 1906 Muller and Speese presented a fairly inclusive bibliography and an excellent summary of the literature up to that date. They summarized Ehrhardt's report of 150 collected cases of carcinoma and ninety-nine cases of sarcoma. To these they added twenty-three cases of carcinoma collected from the literature subsequent to Ehrhardt's report and eight cases of their own. They also brought the collected cases of sarcoma up to 117, including one case of their own. The references given herewith include only those omitted by Müller and Speese and those of articles appearing since the publication of their article. During this period aside from detailed data of individual cases the most important articles are those by Langhans and by Kocher. In American literature four significant reviews with reports of cases have appeared. These are by Crotti, Binney, Porter, and Bouman. The most important contribution which has appeared at any time on the pathology is that by Langhans. Bouman's paper gives an excellent summary of Langhans' article.

ETIOLOGY

General Incidence —Our knowledge of the general incidence of malignant tumors of the thyroid is very meagre for lack of accurate data. That there is

TABLE I
INCIDENCE OF MALIGNANT TUMORS OF THE THYROID SHOWN BY NECROPSY RECORDS

Source of information	Locality	Necropsies	Tumors	Proportion
Muller and Speese	Berne	7,641	82	1 93
Muller and Speese	Vienne	18,147	50	1 362
Muller and Speese	Prague	7,700	17	1 452
Totals for Europe		33,488	149	1 224
Personal communications from pathologists in thirteen hospitals January 1, 1917	Atlantic slope, Baltimore, and cities north thereof	26,375	14	1 1883
Personal communications from pathologists in three hospitals January 1, 1917	Pacific slope, San Francisco	2,966	14	1 211
Personal communications from pathologists in ten hospitals January 1, 1917	Upper Mississippi Valley, St. Louis, and cities north thereof, exclusive of Rochester, Minnesota	7,638	3	1 2546
Necropsy records, Mayo Clinic, January 1, 1905, to December 16, 1920	Rochester, Minnesota (patients mostly from Minnesota and neighboring states)	3,868	13	1 297
	Upper Mississippi Valley, including Mayo Clinic	(11,506)	(16)	(1 719)
Totals for the United States		40,847	44	1 928
Grand Totals		74,335	193	1 385

apparently very great variation in incidence is shown by necropsy records in Table 1

It will be seen that in Berne, one case of malignant tumor of the thyroid was found in every ninety-three post-mortems. This high incidence may be accounted for not only by the high rate of goiter in Switzerland, but also by the presence of Kocher's clinic which attracted goitrous patients from other regions. In Prague the incidence was only one in 452 post-mortems.

In the United States, from information received on request from hospitals where competent pathologists have been in charge of the necropsy service for many years, the highest incidence is in San Francisco, where it is one in 211, and the lowest in the upper Mississippi valley, where it is one in 2,546. This ratio may be influenced by the omission of the cases seen in the Mayo Clinic. In the Mayo Clinic the incidence is one in 297. When this is combined with that of the remainder of the upper Mississippi valley the ratio is one in 719. Although the Mayo Clinic attracts a large number of goitrous patients, particularly from the upper Mississippi valley, the ratio (9.5) of "simple" goiters (the group in which most malignant tumors are said to occur) to exophthalmic goiters is much less than in Kocher's clinic. It must be remembered, however, that these data are very incomplete.

TABLE 2

MALIGNANT TUMORS OF THE THYROID CONCERNING WHICH INFORMATION IS AVAILABLE

Source of information	Epithelial tumors	Sarcomas	Undetermined	Total
Muller and Speese, summary to 1906	181	118		299
Literature 1906 to 1920*	524	39	109	672
Reported in personal communications to author by sixty-seven American surgeons January 1, 1917	98	19	52	169
Mayo Clinic cases, January 1, 1905, to January 1, 1921				
Positive	115	19	83 (Not operated on)	290
Doubtful	73			
Total	991	195	244	1,430

* Reports included in bibliography

The total number of cases of malignant tumors of the thyroid which have been detailed in the literature to date is probably not more than 1,000 (Table 2). Eliminating duplicates the writer was able to collect only 971. Only thirty-four of these have been reported by American authors. It is interesting to compare this small number with the 169 cases reported in personal communications to the writer by sixty-seven American surgeons (not including those in the Mayo Clinic) up to January 1, 1917. At that time none of these 169 cases had been reported in the literature. It will be seen that almost five times as many cases have been met with in the experience of a very small number of American surgeons as had appeared in the entire literature from all American sources. The explanation of this failure to report

cases is found in the reluctance which everyone has in reporting cases of which his primary diagnosis was usually incorrect and his treatment futile

Much of the common impression that malignant tumors of the thyroid are relatively rare is believed to be due in part at least to the high percentage of error of diagnosis. In the Mayo Clinic, of the ninety-seven patients operated on who have died of the disease or who when last heard from were known to have undoubted recurrences, usually metastatic, there were fifty whose clinical histories before the first operation contained no suggestion of malignancy. The glands removed at operation from all of the ninety-seven were examined pathologically, yet at the first operation twenty-three of these were passed by the pathologist without suspicion of malignancy. It is believed that in the last three or four years the percentage of accuracy of diagnosis, both clinical and pathologic, has been very greatly increased in the Clinic, but it is too early to obtain complete mortality statistics in the cases. It is suggested that surgeons should follow up their patients operated on for adenoma of the thyroid, especially after the lapse of three or more years, in order to determine the incidence of death from or recurrence of tumors the malignancy of which was not suspected at the time of operation.

Our knowledge of the relative incidence of malignant tumors of the thyroid compared with our knowledge of malignant tumors of other organs is based on very incomplete information. The impossibility of drawing accurate conclusions from the data at hand is well shown by the marked contrast in the data given by Williams from his analysis of 15,481 primary tumors met with consecutively in the experience in the metropolitan hospitals (London) when compared with the number of tumors found at operation in the Mayo Clinic during sixteen years (Table 3).

TABLE 3

RELATIVE INCIDENCE OF MALIGNANT TUMORS OF THE THYROID AND OF MALIGNANT TUMORS OF OTHER ORGANS OBSERVED AT OPERATION

Organ	Williams (metropolitan hospitals, London)	Mayo Clinic (January 1, 1905, to December 1, 1920)
Uterus	2,649	1,006
Breast	2,442	1,968
Stomach	352	2,073
Lip	352	536
Prostate	9	140
Thyroid	23	207 (plus 83 not operated on)

Geographic Incidence—Inaccuracy of diagnosis is so large a factor as to render vital statistics even in registration areas practically useless for determining the geographic incidence of malignant tumors of the thyroid. Morbidity statistics drawn from even extensive surgical experience like that of Kocher or of the Mayo Clinic embrace a territory too wide and too incompletely covered to be of much value. Thus, in the experience in the Mayo

Clinic, although each year since 1910 a much larger number of patients have registered from Minnesota than from Iowa, and a larger number of patients with simple goiters have come from Minnesota than from Iowa, there has been a much larger number of patients with malignant tumors of the thyroid from Iowa than from Minnesota. These facts were thought to have some significance when first brought out by the compilation of data. A control study, however, was made of the malignant tumors of the breast, and it was found that each year of the same period, except 1910, the total number of patients with malignant tumors of this organ coming from Iowa was greater than those coming from Minnesota. It is now believed that these facts have no etiologic significance, but are influenced by other factors, such as the distribution of surgeons, and the local reputation of places of operation.

While Kocher and most other authors assert with some degree of positiveness that malignant tumors of the thyroid have a greater geographic incidence in those areas in which simple goiters abound, the American necropsy records quoted in Table 1 and the diagnostic experience in the Mayo Clinic give no apparent support to this hypothesis, which may nevertheless be correct.

Incidence in Thyroid Cases —Kocher quotes 235 cases in his own series, on which he had complete data and seventy-six on which he had incomplete data. These were in an operative experience in about 3,500 cases of goiter. He thought he had seen incidentally or in private consultation approximately 100 more cases. In the Mayo Clinic up to January 1, 1921, 10,682 simple goiters and 5,867 exophthalmic goiters had been operated on. Of these 207 were malignant. Besides these 207 there were eighty-three cases in which the diagnosis of malignancy was made but which were inoperable.

None of these patients gave a previous history of true exophthalmic goiter, although the presence of symptoms of true exophthalmic goiter in patients with malignant tumors of the thyroid has been noted by a number of observers.

Age Incidence —In Müller's and Speese' collection, the age incidence at the time of diagnosis is greatest in the fourth, fifth, and sixth decades, with the preponderance in the sixth. In the Mayo Clinic cases the age incidence is similarly greatest in these three decades, but with the preponderance in the fifth.

Sex Incidence —Müller and Speese place the sex incidence as sixty per cent in women and forty per cent in men. In the Mayo Clinic the percentage is sixty-nine in women and thirty-one in men. The distribution by sex is shown in Table 4.

Premalignant Local Conditions —Of the 290 patients in the Mayo Clinic 158 had developed goiter before they were thirty and 106 in the next two decades. One hundred fifty-nine patients had had thyroid enlargement for five years or more. Only sixty-one patients had not noticed thyroid enlargement previous to one year before diagnosis of malignancy. It is probable that a malignant neoplasm of the thyroid may exist for a considerable period with-

TABLE 4

MALIGNANT TUMORS OF THE THYROID, DISTRIBUTION BY SEX (MAYO CLINIC)

	Males	Females	Total
Carcinomas, operated on	24	38	62
Carcinomas (?) not operated on	29	54	83
Malignant adenomas	19	83	102
Malignant papillomas	9	15	24
Sarcomas	8	11	19
Total	89 31 per cent)	201 (69 per cent)	290

out causing pressure or other symptoms which compel the patient to seek medical advice. This renders all statistics concerning premalignant conditions very inaccurate.

COURSE OF THE DISEASE

Onset—It is frequently difficult to elicit a history of definite onset of symptoms referable to malignancy as distinguished from symptoms referable to the presence of supposedly benign tumors of the thyroid. Usually the first symptom leading to suspicion is an increase in size of the gland at a rate greater than that which has continued for some years. Yet this increased growth rate is rapid in only about one-third of the cases, gradual in one-third, and slow in the remainder. Growth usually progresses steadily and without periods of regression in size such as are usually seen in thyroid enlargements of inflammatory origin.

Of the total number of patients examined in the Mayo Clinic about one-fourth had noticed symptoms of continuous growth for one year or less, and about one-third had noticed symptoms of continuous growth for ten years or more. It may be doubted whether the process in the latter was malignant from the beginning of the continuous period of growth. Of the patients whose conditions were considered inoperable at the time of their first examination in the Clinic, more than one-half had noticed symptoms which might be interpreted as indicative of the presence of malignant tumor for one year or less, while one-fourth of them had noticed similar symptoms which had existed for ten years or more. Thus it will be seen that while a sudden increase in rate of growth of a long standing nodular tumor of the thyroid in a patient more than thirty-five is strongly indicative of beginning malignancy, a slow, continuous growth may be almost equally indicative of the same condition. This distinction is important because in much of the older literature the impression is given that the excessive rate of growth is almost always very rapid.

The surface of a malignant thyroid is more apt to be irregular and nodular than when the enlargement is due to inflammation. The irregular nodules are readily palpable. They are, however, not more irregular or nodular at the beginning than are nonmalignant adenomas.

Accompanying the thyroid enlargement, and due to it, are symptoms of pressure on the larynx, trachea, œsophagus, and neighboring nerve trunks. The voice may change, usually deepening. There may be coughing and excess of mucus from the trachea. Even early there may be difficulty in swallowing. Pain in the region of the thyroid, in the neck generally, and extending behind the ears and outward to the shoulders may be an early symptom. There are likely to be cardiovascular disturbances such as arrhythmias, palpitation, and pain resembling angina pectoris. At this early period, the patient's general health may be good, and he may continue his usual vocation until the disease is well advanced before seeking medical advice.

Development —As the disease progresses all the symptoms become aggravated. The pain may become more constant and neuralgic in character. As infiltration of the surrounding tissues occurs the patient complains of "drawing" pains in the gland, which is also tender on pressure. The trachea is often infiltrated, although sometimes only displaced. Invasion of the trachea interferes with its blood supply, causing edema and dyspnoea. Intratracheal hemorrhage may develop early. Interference with respiration may become serious, the patient sleeps in a sitting posture. The pressure on the œsophagus may cause dysphagia. Difficulty in swallowing is probably due at first to spasm, but later to direct pressure.

Later the tumor may become large, hard, and immovable. The pressure from it causes the veins of the neck and arms to stand out prominently. The skin over the tumor becomes red and adherent to it. The patient loses weight and strength rapidly. Cachexia is not nearly so common as in cases of tumors of the alimentary canal, for example, being noted in perhaps not more than one-fifth of all fatal cases.

Metastatic deposits are most frequent in the lungs. The skull, brain, and liver are also frequent sites. A few cases have been reported of malignant tumors of thyroid tissue in organs distant from the thyroid in which necropsy revealed no evidence of malignancy in the thyroid itself.

Termination in Nonoperated Cases —The case may terminate early from edema of the glottis. This is rare, however, and the course of the disease is usually very much prolonged, death finally occurring either from local invasion of neighboring organs or from the effects of extensive metastasis, usually to the lungs, brain, or liver.

Effects of Operation on the Course of the Disease —Early thorough operation gives a fair percentage of cures. When the tumor is in the intracapsular stage and metastasis has not already begun complete resection of the entire lobe of the thyroid involved may result in permanent cure. Unfortunately, however, in a very large percentage of cases the clinical diagnosis is not made until the malignant growth has perforated the capsule of the gland and neighboring organs are extensively involved, or until metastasis to distant organs is well marked.

Another common source of failure of surgical procedures is the surgeon's inability to recognize at operation the malignant character of the growth.

The pathologist also is frequently at fault in his diagnosis. This is particularly true in Langhans' "wucherende Struma," or malignant adenoma. These tumors are frequently diagnosed even on microscopic examinations "fetal adenoma" and the patient sent home with a favorable prognosis. However, he is likely to return in six months or a year with extensive local recurrence. Even at this time the character of the growth is not always recognized either grossly or histologically, and the patient again may be told that the tumor is only benign. These recurrences in proliferating adenomas may come at intervals of from six months to three years for four to eight years before they finally, either by their very great increase in size locally or more usually by extensive metastasis to the lungs, the brain, or the liver, cause death. The great lesson for the surgeon to learn in all nodular tumors of the thyroid in patients of cancer age in which there is not positive evidence of nonmalignancy is that the operation must be radical to the extent of removing every portion of nodular adenomatous thyroid tissue of the side involved. It may even be necessary to clear out all thyroid tissue on both sides, trusting to thyroid feeding for the patient's future metabolic balance. The pathologist must be on the alert to distinguish, if possible, these proliferating tumors from ordinary slow-growing adenomas and adenomatoses.

Surgical operations in late cases after extensive involvement of neighboring organs or distant metastasis may be only palliative, as such, they are frequently warranted.

A detailed study of the results of operation in the cases in the Mayo Clinic is being made by Dr W P Herbst. A brief summary of the post-operative results, however, may be seen in Table 5.

TABLE 5

PERIOD OF RECURRENCE AFTER OPERATION FOR MALIGNANT TUMORS OF THE THYROID

Cases	Patients heard from	Recur- rences	1 or less	Years, postoperative												
				2	3	4	5	6	7	8	9	10	11	12	13	
Malignant papillomas 24	24	8	6				1					1				
Malignant adenomas and carcinomas 164	152	138	44	36	27	9	8	7	3	1			2		1	
Sarcomas 19	18	18	16	2												
Total 207	194	164	66	38	27	9	9	7	3	1	0	1	2	0	1	

The average postoperative life of patients who died of malignant tumors of the thyroid after having been operated on in the Mayo Clinic, or whose conditions were considered inoperable at the time of diagnosis, was approximately six months for patients operated on for sarcoma and for patients with inoperable malignant tumors of unverified type. It was approximately one year and five months for patients with carcinomas, or malignant adenomas, and two years and nine months for patients with malignant papillomas.

MALIGNANT TUMORS OF THE THYROID

PATHOLOGIC CLASSIFICATION AND DIAGNOSIS

General Considerations —Thyroid enlargements aside from hyperemia and inflammatory deposits vary so much in structure and present so little apparent relationship between their structure and the associated symptoms that diagnosis and classification are always extremely difficult. Perhaps for a clearer understanding we may lay aside for the moment our previously conceived ideas, our theories with regard to origin, and our impressions derived from exceptional or limited observations, and attempt first to blaze out certain broad general conceptions of the group.

Speaking from an experience gained in the pathologic study of about 14,000 human thyroids it seems to me that the following general conceptions may be formulated. Aside from hyperemia and inflammatory deposits, thyroid enlargements, as met with at operation and necropsy, are directly due either to storage of secretion or proliferation of tissue or to both. If due to storage of secretion, they are colloid goiters. If due to diffuse proliferation (hyperplasia) of normal adult tissue which hyperfunctions, they are exophthalmic goiters. If due to circumscribed proliferation of (usually embryonal) parenchymatous tissue, they are adenomas. If these adenomas remain perfectly encapsulated and if they cease to proliferate and gradually degenerate they are "benign," in the sense that they do not invade surrounding structures and do not metastasize. They may, however, cause untoward local symptoms from pressure and they may be associated with a symptom syndrome, the chief characteristic of which is usually a slowly developing hypermetabolism with cardiac disturbances but rarely with exophthalmos, a syndrome which H. S. Plummer designates "toxic non-exophthalmic goiter" or "toxic adenoma."

If adenomas continue to proliferate rather than to degenerate they may penetrate their capsule, invade the other portions of the gland or surrounding structures and metastasize, ultimately causing the death of the patient by destruction of either local or distant organs. These proliferating adenomas (the "wucherende Struma" of Langhans) thus may or may not be malignant and histologically it is almost impossible to differentiate the two. Broadly speaking, the only reliable marks of distinction are the details which indicate the predominance of one or the other of the two processes, namely proliferation and degeneration. Again, broadly speaking, it follows from this, that any sizable adenoma of the thyroid composed of embryonal tissue in a person of cancer age which histologically shows that it is in active proliferation is potentially malignant even though it is still contained entirely within its capsule. This consideration, based on data supplied by a competent pathologist, should guide the surgeon at the time of operation in the extent of his operative procedures.

Neoplasms of the thyroid composed of adult parenchymatous cells, if encapsulated, always suggest having been derived from embryonal tissue during postnatal life though by no means can this always be proved. Langhans considers them late stages of "wucherende Struma." Such encapsulated masses of large adult parenchymatous cells, while frequently arranged in

acini resembling those of the normal thyroid, are more frequently the subject of extensive degeneration. And such degeneration may be sufficiently extensive to produce sloughing or broken-down areas. The epithelial cells adjacent thereto are large, often with hydropic cytoplasm and relatively small nuclei. The parenchyma is not infrequently markedly papilliferous. Such adenomas composed of epithelium, apparently adult in all respects, are associated with clinical conditions parallel with those mentioned as coincident with adenomas of embryonal type. They may cause only local pressure symptoms, they may be associated with the syndrome of toxic adenoma (Plummer) or they may invade surrounding structures and metastasize to distant organs thus placing them in the class of malignant neoplasms. They are undoubtedly the origin of that group of malignant tumors usually designated adenocarcinomas.

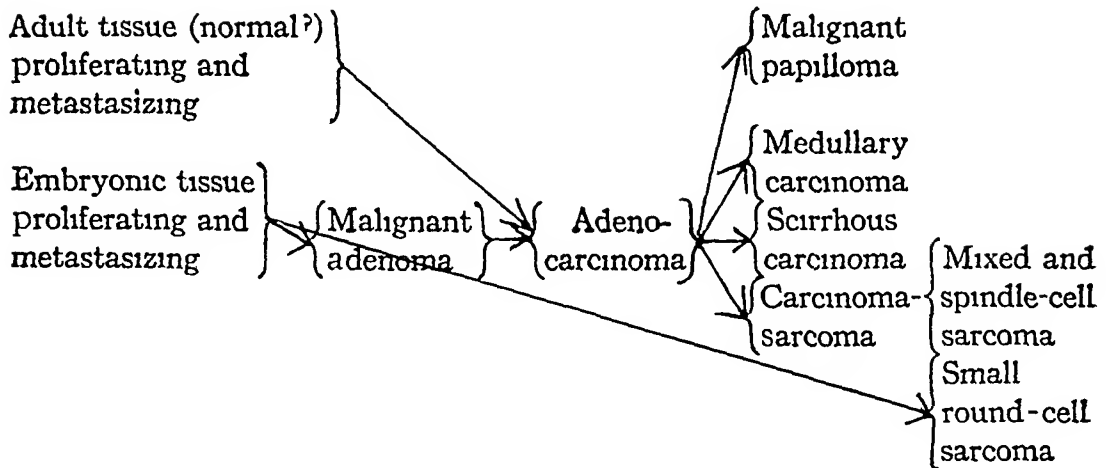
Occasionally there is met with an aberrant diffuse proliferation of parenchyma of the thyroid with little or no evidence of the formation of normal secretion or of the storage of colloid and without evidence of encapsulation except the normal capsule of the entire lobe. It is believed that such tumors may exist without causing other than local symptoms and these but slight. I have seen not more than ten or fifteen of these in my entire experience. On the other hand, solid homogeneous non-functionating aberrant proliferations of the thyroid are almost always neoplasms which invade surrounding structures and metastasize to distant organs. While in one sense these are adenocarcinomas, for the sake of clearness, let us leave out of account their suggestion of nodular encapsulated neoplasms and refer to them simply as carcinomas of the thyroid.

All other tumors of the thyroid associated with symptoms of malignancy are usually described as sarcomas. Beside their connective tissue elements in which any form of sarcoma cell may be the dominant one, although it is most frequently the spindle-cell type, there are also almost invariably present large or small groups of parenchymatous cells which show that they are also proliferating. Whether or not the neoplastic process started with the parenchymal elements which were later destroyed by a secondary proliferation of the connective tissue elements, or whether the process was from the beginning a proliferation of the connective tissue elements with only secondary stimulation of the parenchymatous cells as they were gradually squeezed out, it is impossible to say. There is usually a history of recent rapid development, and the prognosis of the early demise of the patient must be made. We must continue to call these tumors sarcomas whatever may be our hypothesis with regard to their epithelial or mixed origin.

MORPHOLOGIC RELATIONSHIPS

In studying the pathologic diagnosis of malignant tumors of the thyroid, some assistance may be obtained by following in reverse order, the diagram presented herewith.

MALIGNANT TUMORS OF THE THYROID



This diagram is an attempt to express what appear to be the gradations from tumors of one type of tissue to those of other types which have been found in the series of malignant tumors of the thyroid herewith reported. It is possible that other types exist, but they have not come under my observation. Thus, no hard and fast line of differentiation can be drawn between tumors composed of embryonic tissue (fetal adenoma, wucherende Struma, Langhans) which is proliferating and metastasizing and those types of adenomas composed of cells approaching the adult type but arranged in fairly normal acini or in bands. Nor is it possible to draw hard and fast lines between tumors of this latter type of tissue and tumors composed of cells of more or less adult type forming tissue masses, most of which are composed of cells rather densely packed together and showing only here and there enough evidence of their acinar arrangement to indicate their thyroid gland origin, and hence called adenocarcinomas. Adenocarcinomas in turn are subject to at least four types of variation, which in their extreme development are readily recognized, but which grade into ordinary adenocarcinoma of the solid type and even into each other in all degrees of variation. As a rule it is much easier to determine histologically the malignancy of adenocarcinomas, including the four principal variations, papilloma, medullary carcinoma, scirrhus carcinoma, and carcinosarcoma, than it is to determine histologically the malignancy of either adult or embryonic adenomas.

ILLUSTRATIVE CASES

The following illustrations show the principal tumor types in inverse order of the diagram beginning with those which are most easily recognized. The illustrations are presented in the hope that they may assist other observers in making diagnoses. Only enough of the clinical history is presented to serve as a check on the pathologic diagnosis.

MALIGNANT PAPILLOMA

Case I (A53517) A man, aged sixty-five, had had goiter two years before operation. The left lobe, isthmus and lower pole of the right lobe were extirpated. Sixty grams of tissue were removed. Recurrence followed in eight months, and the patient died three years after the operation.

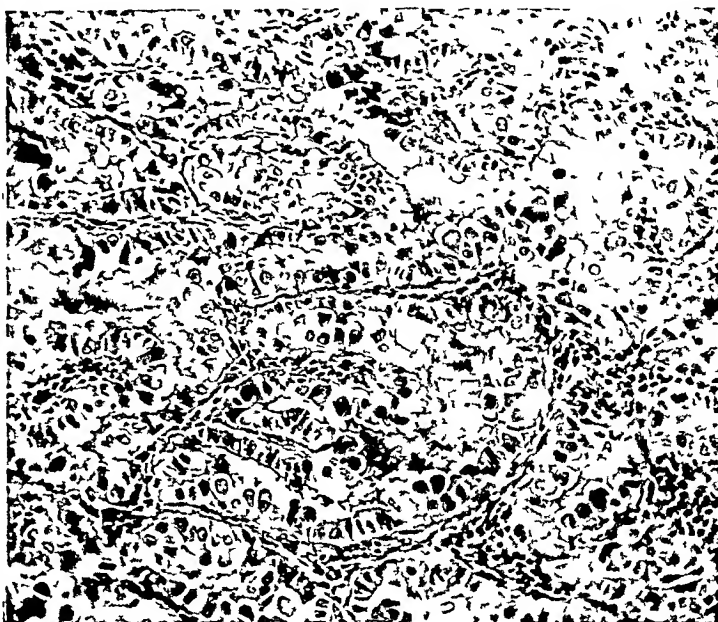


FIG 1 (Case A53517) —The papillæ bear large functioning cells (see colloid and surrounding clear spaces) with sharply staining nuclei and mitotic figures. Malignant papilloma. $\times 100$

MALIGNANT TUMORS OF THE THYROID

MALIGNANT PAPILLOMA

Case II (A85166) A man, aged fifty-one, had had goiter for eighteen months, rapidly growing for five months. At operation a malignant papilloma of the right lobe, involving the trachea and muscles was found. One hundred thirty-two grams of tissue were removed. There was a rapid recurrence of the tumor and the patient died two and one-half months after the operation.

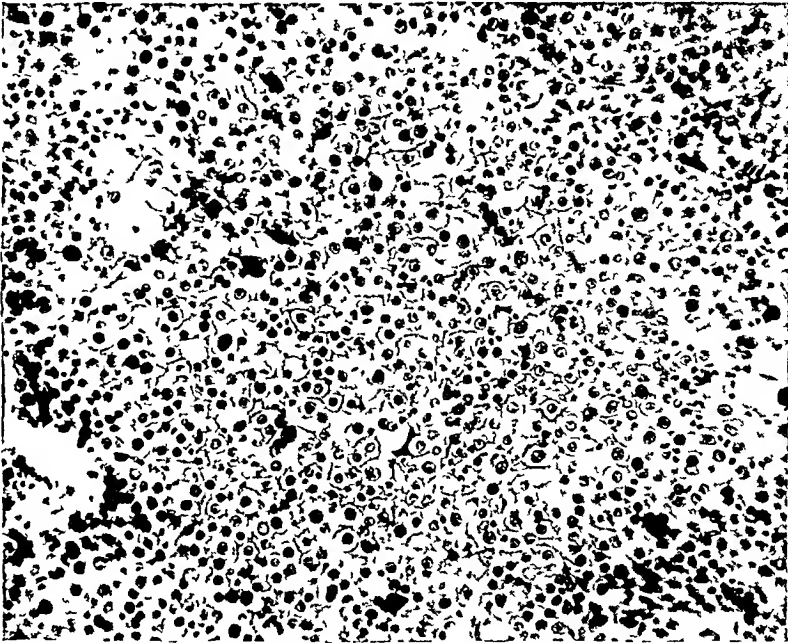


FIG. 2 (Case A85166) —A section through the base of the papillæ which resemble those shown in Figure 1. Large and small epithelial cells showing evidence of rapid proliferation. Malignant papilloma. X100.

NON-MALIGNANT PAPILLOMA

Case III (39582) A woman, aged thirty-seven, had had goiter for two years. The left lobe and isthmus were extirpated. The growth was a papilloma. Twenty-eight grams of tissue were removed. The patient's recovery was uneventful, and there was no recurrence during a period of ten years after the operation.

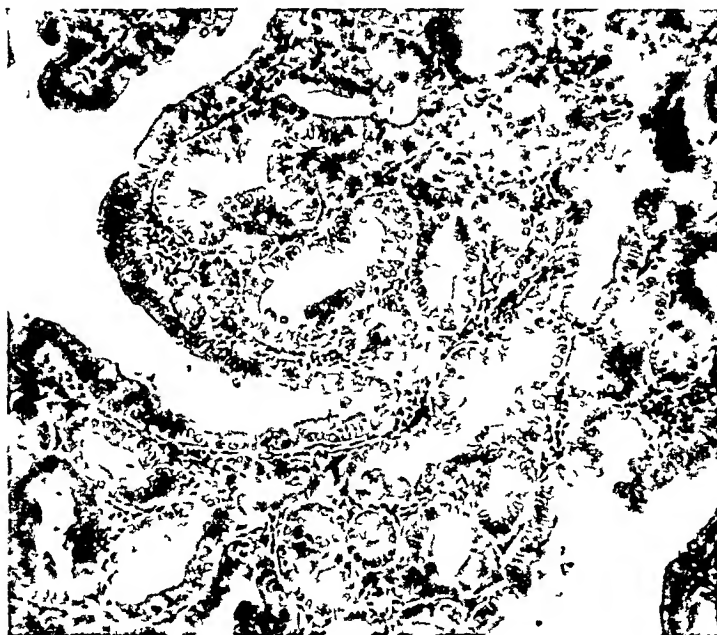


FIG 3 (Case 39582) —High columnar epithelium with small nuclei; no mitosis. Non malignant papilloma. X100

NON-MALIGNANT PAPILLOMA

Case IV (A95417) A woman, aged twenty-three, had had goiter for seven years previous to operation. Cysts were enucleated from the right lobe and isthmus. Forty-five grams of tissue were removed. There was no recurrence during seven years after operation.

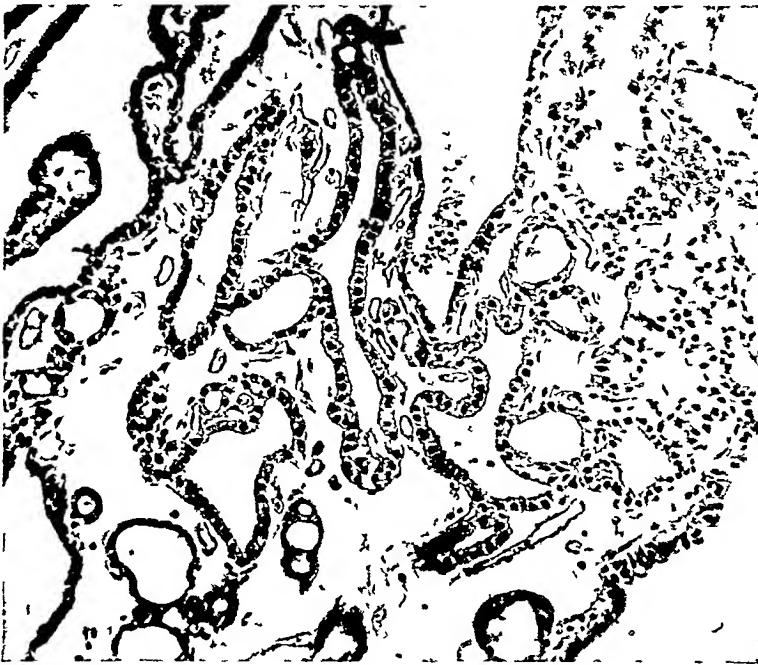


FIG 4 (Case A95417) —Note clear hyaline centers of papillæ small epithelial cells with shrunken nuclei without mitosis. Non-malignant papilloma X100

ADENOPAPILLOMA

Case V (A47855) A man, aged forty-nine, had had goiter for five years with rapid growth for one year. The right lobe and isthmus were extirpated for impending suffocation. Four hundred twenty-five grams of tissue were removed. Recurrence followed within one year, there were nodules in the scar, and hemorrhages apparently from the larynx. Death occurred eighteen months after the operation.



FIG 5 (Case A47855) —Rapidly proliferating papilloma X100

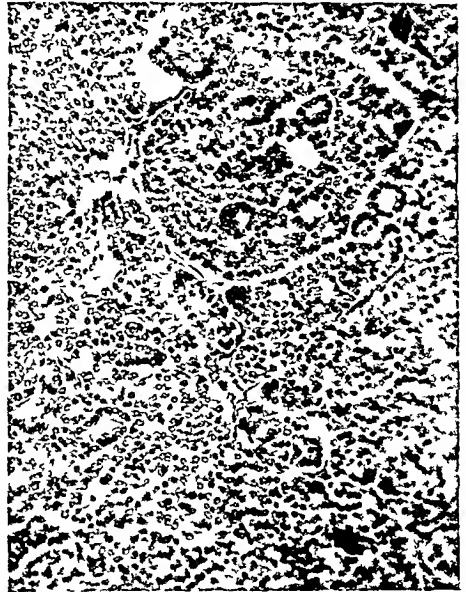


FIG 6 (Case A47855) —Adenomatous area showing only slight tendency to papillae formation. Small embryonic cells with relatively large nuclei. Adenopapilloma malignant X100

MALIGNANT TUMORS OF THE THYROID

ADENOPAPILLOMA (MALIGNANT)

Case VI (A94082) A woman, aged forty, had had goiter for sixteen years with accelerated growth for two years. A dense calcareous goiter was adherent to the trachea, and all the anterior muscles were involved. It was impossible to remove the entire growth. Fifteen grams of tissue were removed. X-ray treatments were given for four months, during which time the growth largely disappeared, it recurred three years after operation. The patient is alive and not suffering serious inconvenience six years after operation.



FIG 7 (Case A94082) —A section at the base of the papillomatous area. The epithelial cells are evidently proliferating. X100

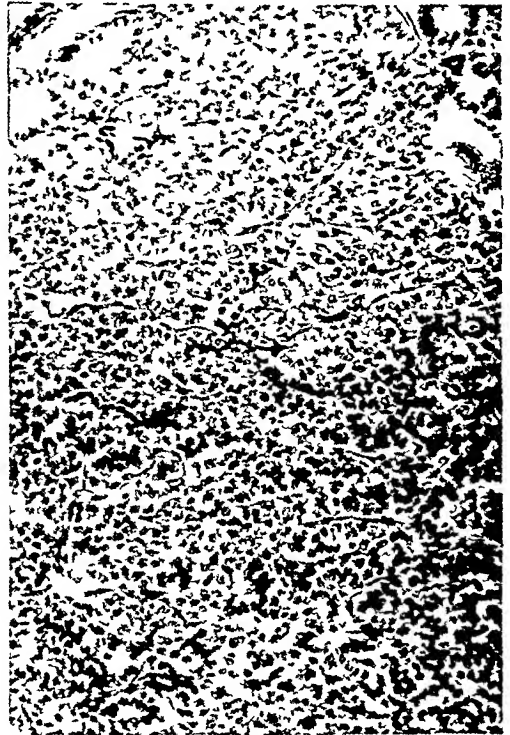


FIG 8 (Case A94082) —Adenomatous area, small partly differentiated cells with relatively large nuclei separated into short irregular twisted cords by thin-walled flat capillaries. Adenopapilloma malignant. X100

MEDULLARY CARCINOMA

Case VII (A16767) A man, aged forty-eight, had had goiter for five years, slowly growing for the last few months. The right lobe and isthmus were extirpated. Four hundred grams of tissue were removed. The patient was reexamined twenty-two months later, and then had obstruction and dyspnea. A hard, nodular tumor five by five inches was found in the right thyroid region, it had grown rapidly for the last few months. The patient died two years after operation.



FIG 9 (Case A16767) —A gross section through the tumor showing fibrous scar-like center with adenomatous subcapsular portion and fibrous lines radiating from the center to the capsule. This arrangement is typical of the proliferating embryonic adenomas and suggests the origin of this medullary carcinoma from such a tumor. Medullary carcinoma



FIG 10 (Case A16767) A section from the fibrous area showing large epithelial cells in small acini generating. $\times 100$

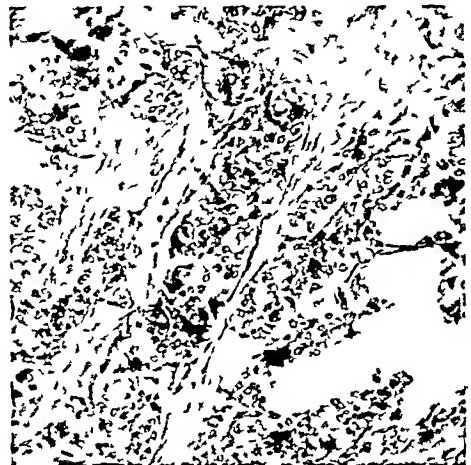


FIG 11 (Case A16767) —A section through the soft portion of the tumor. Portions of three large acini shown densely crowded with medium sized epithelial cells which are breaking down one area of colloid. $\times 100$

MALIGNANT TUMORS OF THE THYROID

MEDULLARY CARCINOMA

Case VIII (A44143) A man, aged forty-one, had had a hard goiter for twenty years, it had enlarged rapidly during the last year. An adenoma of the isthmus, which invaded both lobes, penetrated at the base, and involved the muscles, the mediastinum was enucleated. Three hundred five grams of tissue were removed. One month after operation a rapidly growing tumor recurred. The patient died two months after the operation.



FIG. 12 (Case A44143) —A section through the soft portion of the tumor showing large proliferating and degenerating epithelial cells in loose acini. Medullary carcinoma. X100

MEDULLARY CARCINOMA

Case IX (A109792) A man, aged sixty-five, had had goiter for twenty-two years; growing more rapidly for the past eight years. A clinical diagnosis was made of multiple adenomas, possibly malignant. The patient refused operation. He returned twenty-one months later, having used local applications. The tumor was slightly larger than before, inflamed and more fixed. The pyramidal and median lobes were resected. Three hundred ninety-five grams of tissue were removed. One month later a recurring growth was removed by the Percy cautery. The cautery was used again in one month, followed by radium treatment. The patient died three months after the first operation.

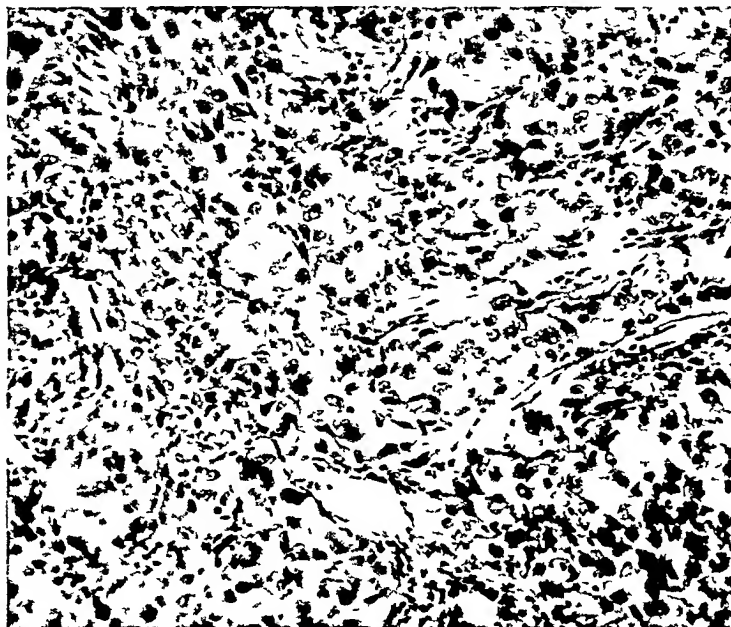


FIG 13 (Case A109792) —Large epithelial cells evidently rapidly proliferating some acinar arrangement. Medullary carcinoma. $\times 100$

MALIGNANT TUMORS OF THE THYROID

ADENOMEDULLARY CARCINOMA

Case X (A119660) A woman, aged forty-three, had had goiter for fourteen years with accelerated growth for five years. An adenoma of the isthmus which invaded both lobes was removed. Two hundred forty grams of tissue were removed. The tumor recurred two and one-half years after the operation. The patient died three years after the operation with extensive metastasis in the lungs.



FIG 14 (Case A119660) — A gross section through a portion of tumor showing typical proliferating adenoma arrangement. Adenomedullary carcinoma. X100



FIG 15 (Case A119660) — A section through the softer portion of tumor showing large epithelial cells proliferating and degenerating lying in well-marked cords and follicles. The character of cells indicates the beginning medullary type. Arrangement shows plainly adenomatous origin. X100

ADENOMEDULLARY CARCINOMA

Case XI (A96681) A woman, aged thirty-four, had had goiter for eight years. A partial thyroidectomy had been performed twice elsewhere during the last two years. No pathologic examination of the tissue removed at these operations had been made. There had been a recent rapid growth. All of the right lobe except the superior pole was removed. Seventy-two grams of tissue were removed. Three months later a rapidly recurring growth including tissue from behind the larynx was removed by excision and cautery, and a tracheotomy performed. Death occurred one month later. Extensive metastasis was found to the lungs, lymphatics and left sternoclavicular articulation.

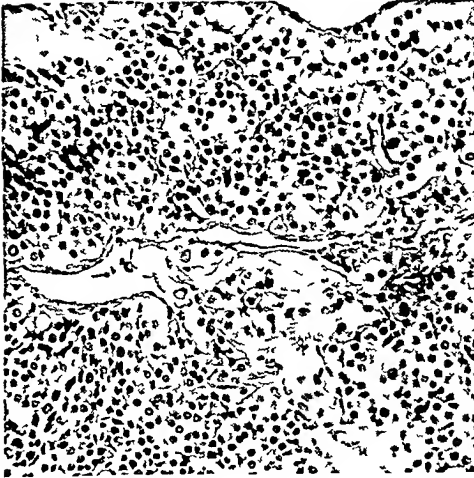


FIG 16 (Case A96681)—A section through the more solid portion of the thyroid tumor. Large epithelial cells showing traces of alveolar arrangement. $\times 100$

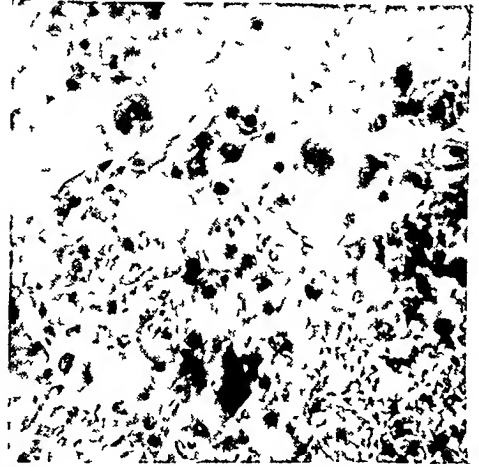


FIG 17 (Case A96681)—A section through the soft portion of the recurring tumor showing a medullary type of cells. $\times 220$



FIG 18 (Case A96681)—A gross section through the lungs. Light areas show metastasis. Adenomedullary carcinoma.

MALIGNANT TUMORS OF THE THYROID

SCIRRHOUS CARCINOMA

Case XII (G6848) A man, aged forty-eight, had noticed gradual trouble in the right side of his neck and in his tonsils for the past year. The right lobe of the thyroid, the sternomastoid, and omohyoid muscles, the internal jugular and the lymphatics on the right side were removed. One hundred grams of tissue were removed. Four years after the operation the patient wrote, "I think the operation could not have been better, neck has not swelled or bothered me since. Now have asthma more or less." The patient died five years after the operation with involvement of the lungs.

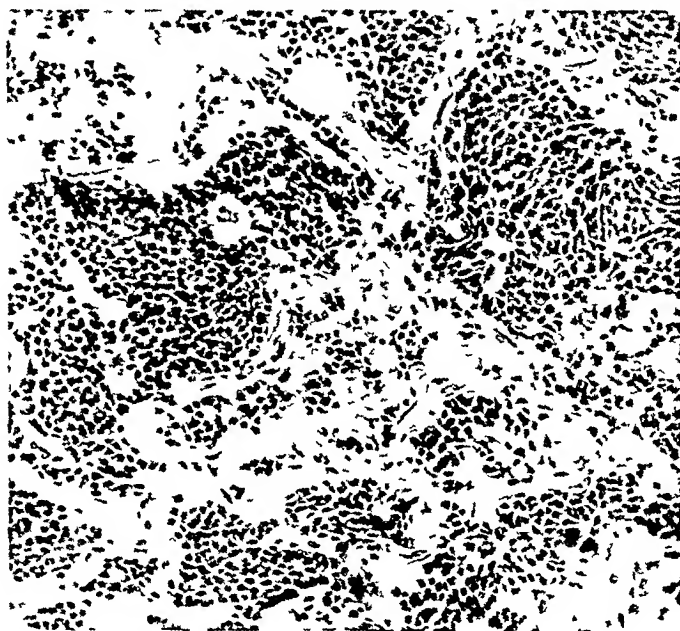


FIG 10 (Case G6848) —A section through a hard portion of the tumor in the thyroid showing epithelial cells much condensed by fibrous connective tissue. Scirrhous carcinoma. $\times 100$

SCIRRHOUS CARCINOMA

Case XIII (A68082) A man, aged twenty-six, had had a small tumor on the right side of his neck since childhood, it had enlarged in the past two years. Three years before it had been diagnosed goiter by his physician. He had been dyspnoeic during the past year. On exploration a large intrathoracic tumor was found which could not be removed and tracheotomy was performed. Twenty grams of tissue were removed for diagnosis. The patient died three days after the operation. Necropsy revealed a tumor involving the trachea, which was reduced to ribbon shape and extended into the mediastinum to the pericardium. The mediastinal glands were involved. There were numerous metastatic nodules in the liver and spleen.

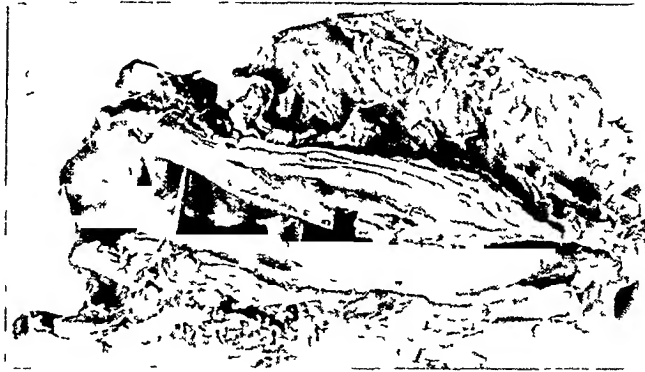


FIG 20 (Case A68082)—The trachea opened from behind showing small carcinomatous nodules under the mucosa



FIG 21 (Case A68082)—Epithelial cells condensed by fibrous connective tissue. Scirrhous carcinoma. X100

MALIGNANT TUMORS OF THE THYROID

SCIRRHOUS ADENOCARCINOMA

Case XIV (A89086) A woman, aged thirty-four, had had goiter for twenty years, with accelerated growth for five years but no serious symptoms until seven months before. The left lobe of the thyroid was extirpated. Twenty-five grams of tissue were removed. The patient died nine months after the operation from recurrence.

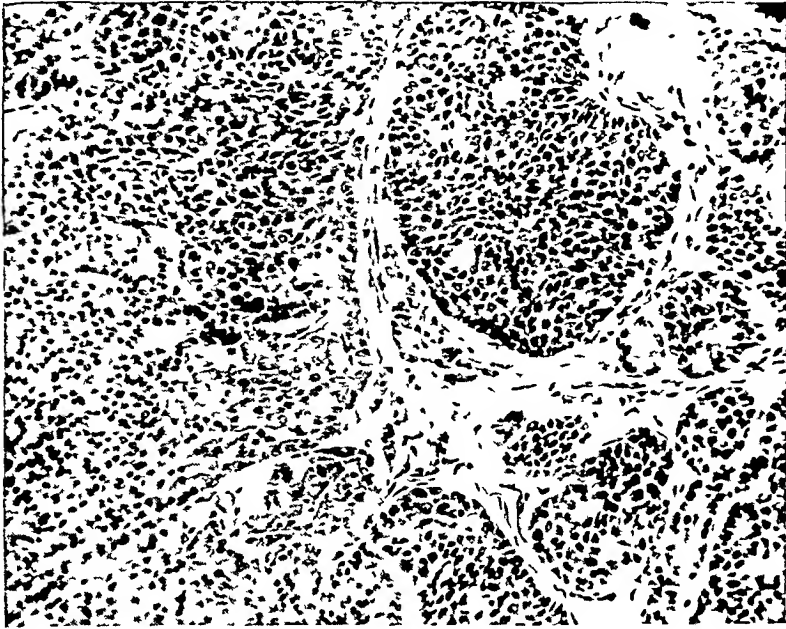


FIG. 22 (Case A89086) —Epithelial cells in crowded acini, nuclei though distorted resemble those in embryonic cells suggesting derivation from proliferating embryonic adenoma. Scirrhous adenocarcinoma. X100.

MIXED CELL SARCOMA

Case XV (A19893) A woman, aged thirty-nine, had had goiter for seven years, with rapid growth during the last six months. A firm, almost hard, spherical, movable enlargement was palpated in the right lobe of the thyroid. The tumor, which was about 7 cm in diameter, was attached to the trachea and had infiltrated through the capsule. One hundred thirty-six grams of tissue were removed. Six centimeters of the right internal jugular were removed with the tumor. Death occurred six months after the operation.

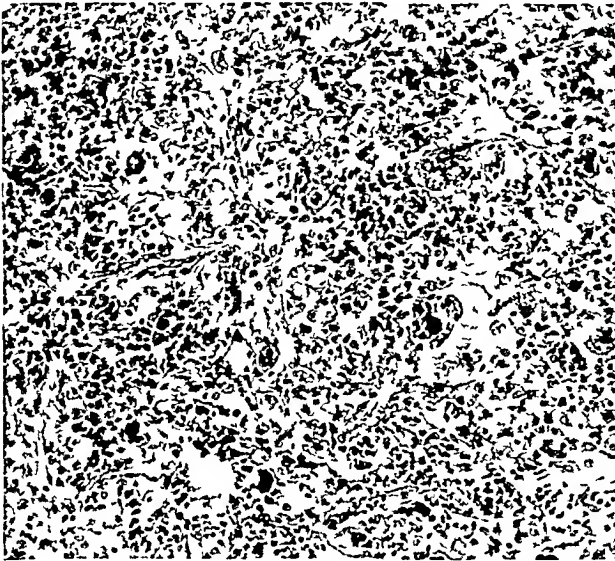


FIG 23 (Case A19893) —Mixed round spindle and giant cell sarcoma $\times 100$

SPINDLE CELL SARCOMA

Case XVI (A59130) A man, aged fifty-six, had had goiter for twelve years, with accelerated growth for about three years. The left lobe and isthmus were extirpated, the tumor was infiltrating the muscle. Two hundred twenty grams of tissue were removed. The patient died two months after the operation.



FIG. 24 (Case A59130) —A section through a gross specimen showing solid and spongy areas.

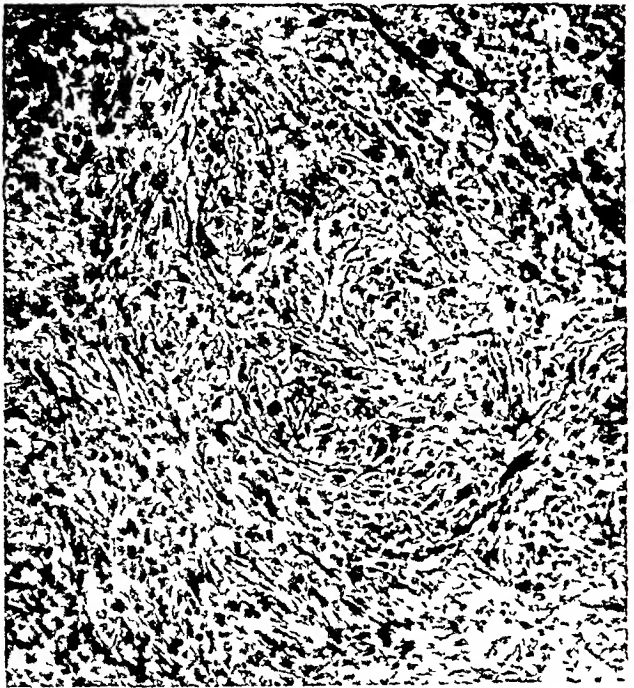


FIG. 25 (Case A59130) —A section through a solid area showing spindle-cell sarcoma with a few round cells. X100.

ALVEOLAR SARCOMA SUGGESTING EPITHELIAL RELATIONSHIP

Case XVII (A139004) A woman, aged sixty-four, who did not give a history of previous goiter, had noted a rapid growth of the thyroid for three months. At exploratory operation, a small piece of tissue was removed for diagnosis. Death occurred four months after the operation.

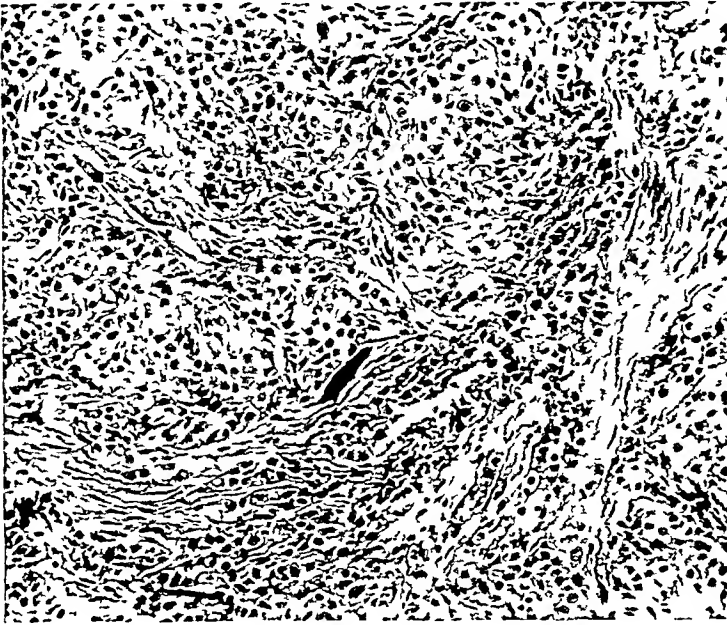


FIG. 26 (Case A138014) —Alveolar sarcoma $\times 100$

MALIGNANT TUMORS OF THE THYROID

CARCINOMA SARCOMA

Case XVIII (A163873) A woman, aged fifty-two, had had goiter for thirty-seven year with accelerated growth for one year A total thyroidectomy was performed for advanced malignant tumor, involving the right lobe of the thyroid Two hundred ten grams of tissue were removed from the right lobe The growth recurred nine months after the operation



FIG 27 (Case A163873) —A section through the gross specimen showing a tumor developing in the adenoma in the old colloid goiter

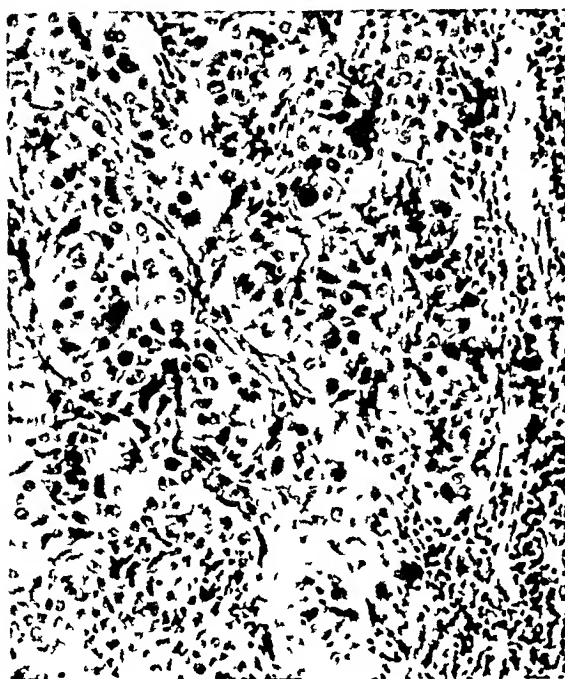


FIG 28 (Case A163873) —A section through the portion of solid tumor near the capsule showing proliferation of both epithelial and connective tissue elements X100

CARCINOMA SARCOMA

Case XIX (A57935) A woman aged sixty-three, had had very hard deep lying tumors in the right and left lobes of the thyroid for four years. The entire thyroid gland was extirpated. Two hundred grams of tissue were removed. The patient remained apparently well for six years, then died within nine months of rapid recurrence with extensive metastasis.

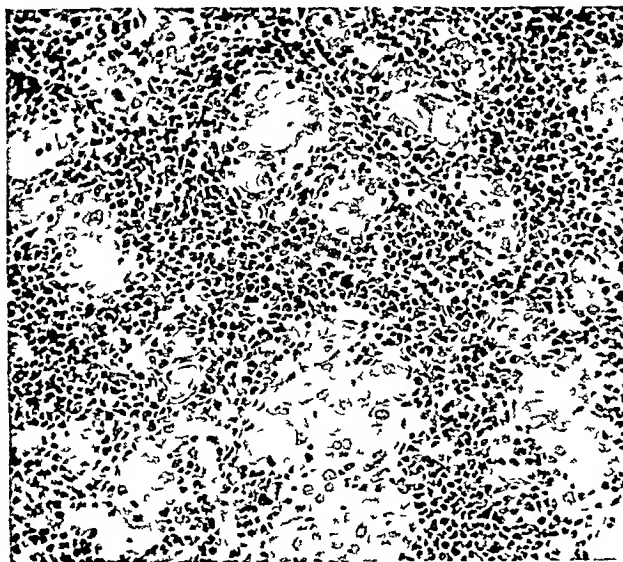


FIG 29 (Case A57935) —A section through the edge of the tumor showing proliferated epithelial cells which are now degenerating and proliferation of connective tissue cells between the acini. Carcinoma sarcoma. $\times 100$

MALIGNANT TUMORS OF THE THYROID

ROUND AND GIANT CELL ADENO-SARCOMA

Case XX (A32772) A man, aged seventy, had had goiter for sixteen years which had gradually enlarged for eleven years, remained stationary for three years, and then gradually enlarged for two years. A hard nodular goiter was enucleated from the left side. Two hundred twenty grams of tissue were removed. The growth recurred in two months and death occurred in four months.



FIG. 30 (Case A32772)—Sarcoma composed of small round and giant cells; small round cells still showing marked evidence by their grouping of their origin as an embryonic adenoma. $\times 100$

SMALL ROUND CELL SARCOMA

Case XXI (A182791) A woman, aged fifty-nine, had had goiter for one year, with accelerated growth for two months. The entire right lobe and isthmus and all of the left lobe except a piece of gland half the size of a normal lobe which was left at lower pole were removed. One hundred sixty-five grams of tissue were removed from the right lobe, seventy grams were removed from the left. The patient was re-examined four months after the operation. She was dyspnoeic on exertion, worse during the last two months. Death occurred two years after the operation from "trouble with lungs", no necropsy.



FIG 31 (Case A182791) —A section through the more solid portion of the tumor showing small areas of colloid thyroid (dark) here and there in the tumor

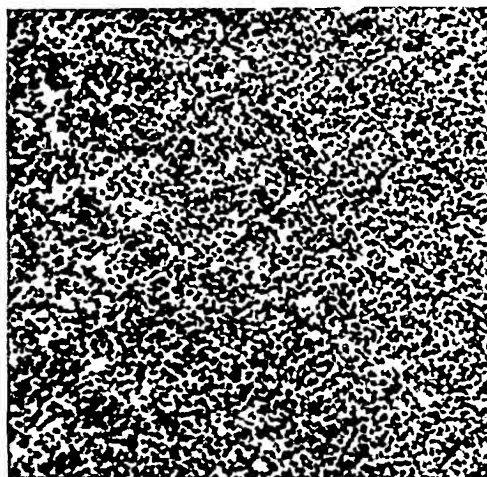


FIG 32 (Case A182791) —Small round-cell sarcoma. In some areas cell grouping suggests that in embryonic adenomas. X100

MALIGNANT TUMORS OF THE THYROID

SMALL ROUND-CELL SARCOMA

Case XXII (A30889) A woman, aged fifty-two, had had a slowly growing goiter for one year. The entire gland was extirpated. Eighty-six grams of tissue were removed. The growth recurred two months later and was treated by X-ray. There was some evidence of metastasis five and one-half years after operation. Death occurred six years after operation.



FIG. 33 (Case A30889) —Small round cells here and there in groups suggesting partially differentiated embryonic adenomatous tissue. Small round-cell sarcoma. $\times 100$

ADENOCARCINOMA

Case XXIII (P5459) A woman, aged sixty-six, had had goiter for thirty years, rapidly growing for four months. She was dyspnoeic, had mucus in the trachea that was hard to get up. A complete thyroidectomy was performed. Three hundred eighteen grams of tissue were removed. Death occurred one year after the operation.



FIG. 34 (Case P5459) —A section through the gross specimen showing encapsulated mass of tumor tissue (light) advancing into colloid areas (dark)

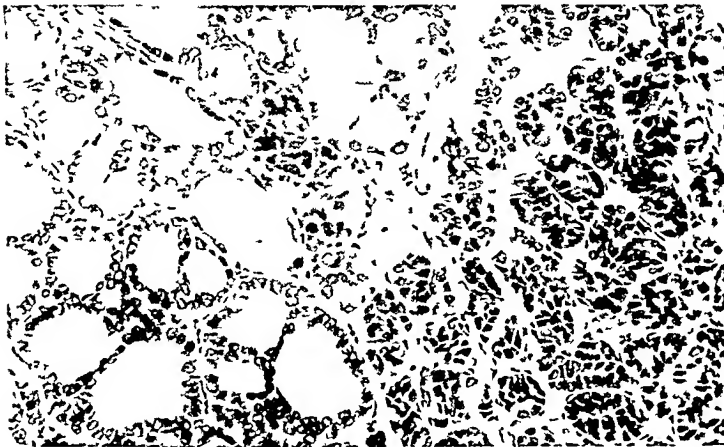


FIG. 35 (Case P5459) —Edge of the tumor area showing adenocarcinoma in colloid adenoma $\times 100$

MALIGNANT TUMORS OF THE THYROID

ADENOCARCINOMA

Case XXIV (A26084) A woman, aged thirty-eight, had had a gradually growing goiter for four years. An adenoma was enucleated from the left lobe of the thyroid. Forty-eight grams of tissue were removed. Six years after the operation a rapidly growing recurrent tumor developed. Death occurred six and one-half years after operation from involvement of the larynx and trachea.

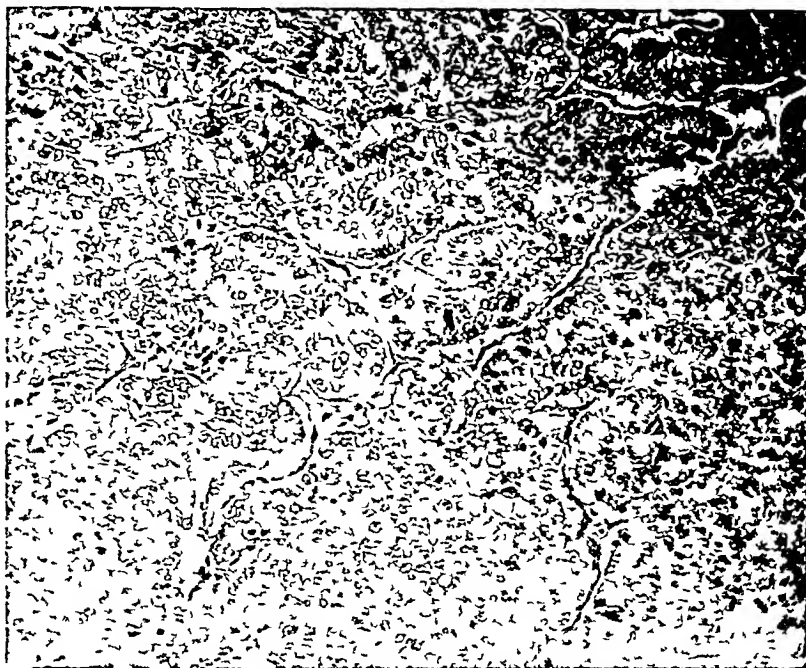


FIG 36 (Case A26084)—Carcinoma composed of adult epithelial cells in some places arranged in irregular whorls like those of proliferating embryonic adenomas
X100

ADENOCARCINOMA

Case XXV (A91931) A man, aged fifty seven, had had goiter for eighteen months. Thyroidectomy was performed, the trachea was freed, and a portion of the right lobe removed. Twenty grams of tissue were removed. The tumor which originated in and involved mainly the right lobe, had perforated the muscles and involved the sternomastoid muscle on the right side. X-ray treatment was given for three months, then the cancer eroded through the skin. The patient went to a "plaster specialist." Several severe hemorrhages occurred after the "plaster treatment." The patient died one year after operation.

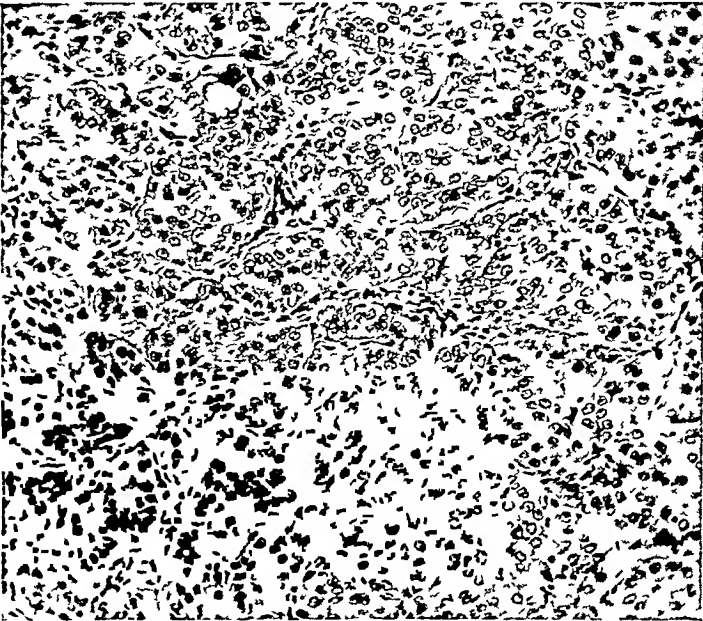


FIG. 37 (Case A91931) —Adenocarcinoma composed of adult epithelial cells arranged everywhere in masses typical of embryonic proliferating adenomas
 $\times 100$

MALIGNANT TUMORS OF THE THYROID

MALIGNANT ADENOMA

Case XXVI (A23842) A woman, aged twenty-seven, had had goiter for ten years, it had grown gradually until about two months before when it began to increase more rapidly. A nodular tumor of the right lobe was extirpated. One hundred ninety grams of tissue were removed. The patient returned for examination four years after operation with recurrence of a tumor in the right lobe. The entire right lobe of the thyroid, which was fixed to the trachea and cricoid cartilage and involved the larynx, was removed. One hundred grams of tissue were removed. Two and one-half years after the second operation the patient reported that the gland was enlarging slowly, she was growing weaker and showing some cachexia. Death occurred eight years after the first operation from tracheal involvement and probably metastasis to the lungs.



FIG 38 (Case A23842) —A section through a gross specimen showing the ordinary type of proliferating adenoma with gland tissue in the center of the nodule replaced by connective tissue

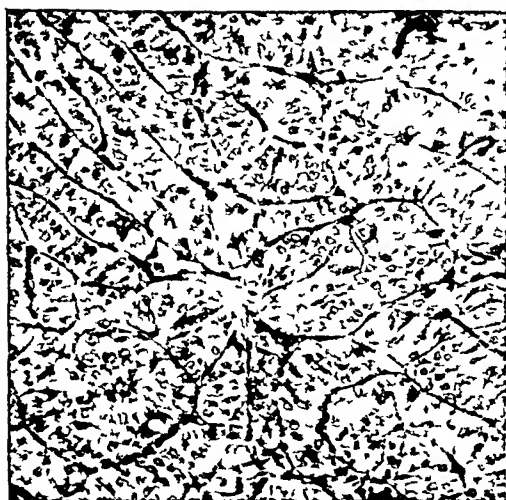


FIG 39 (Case A23842) —A section through the solid area of a tumor near the capsule showing adult epithelial cells in lobules and long narrow bands corresponding to Langhans' description, mitosis in cells. X100



FIG 40 (Case A23842) —A section through a looser area. Lobules arranged in short whorls. Cells show colloidal though definite acini are absent. X100

PROLIFERATING EMBRYONIC (FETAL) ADENOMA, MALIGNANT

Case XXVII (A164145) A man, aged fifty-one, had had goiter for seventeen years with accelerated growth for five years. There was slight hyperthyroidism. An adenoma was enucleated from the right lobe of the thyroid. The gland was densely fixed posteriorly. Four hundred eighty grams of tissue were removed. X-ray and radium treatment were given for one month following the operation. Five months after the operation, examination revealed considerable enlargement of the right lobe. The patient was alive and well when last heard from two years after the operation.

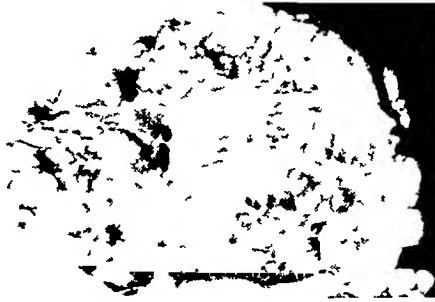


FIG 41 (Case A164145) —A section through the gross specimen showing extensive hyaline and fibrous degeneration. Compare this with Figures 38, 44 and 46.

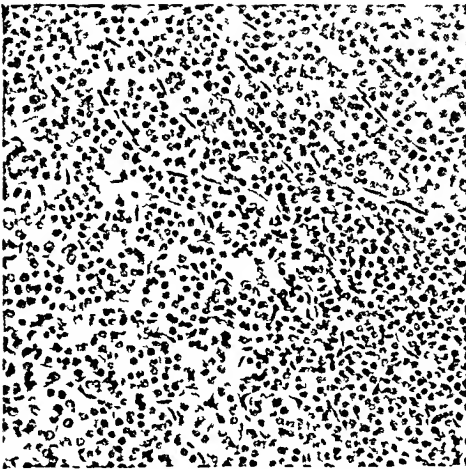


FIG 42 (Case A164145) —A section through the dense portion of the adenoma immediately under the capsule. Note small embryonic cells arranged in lobules and bands with a very small amount of stroma (thin-walled blood-vessels) between. $\times 100$

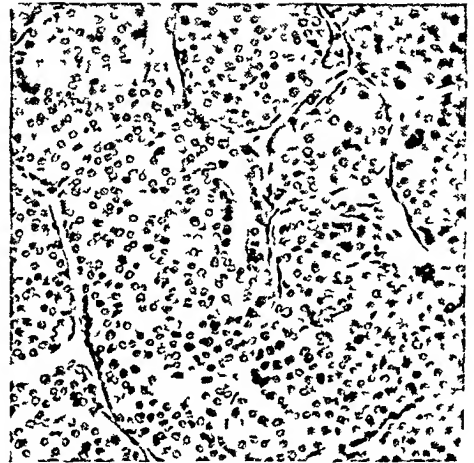


FIG 43 (Case A164145) —A section from an area farther from the capsule than that shown in Figure 42. The embryonic cells are larger and in larger lobules marked off by cleft formed blood-vessels. $\times 100$

MALIGNANT TUMORS OF THE THYROID

PROLIFERATING EMBRYONIC (FETAL) ADENOMA, MALIGNANT

Case XXVIII (A155669) A man, aged forty-five, had had goiter for twenty years with accelerated growth for two years. Two partial thyroidectomies had been performed elsewhere, twelve and seven years before respectively. No data were obtainable concerning the character of the removed tissue. A partial thyroidectomy was performed. Forty-five grams of tissue were removed. Four months later the home physician reported that the patient was in good health and working every day. One year after the operation serious pressure on the trachea was reported. Death occurred one year and four months after the operation, following tracheotomy for pressure made by a large tumor of the thyroid. No necropsy was made and no data were obtainable concerning the histology of the tumor or of possible metastasis.



FIG. 44 (Case A155669) —A section through the small adenoma removed at the third operation (the first in the Mayo Clinic). The entire nodule made up of actively growing tissue.

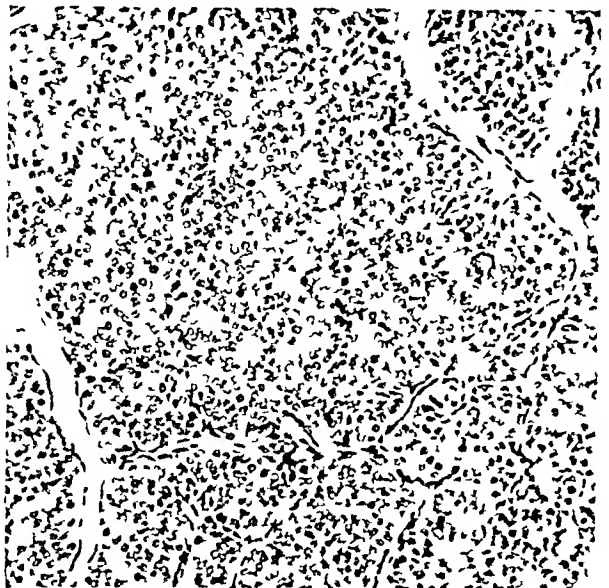


FIG. 45 (Case A155669) —A section through the tumor showing proliferating embryonic epithelium in some areas arranged in lobules. $\times 100$

PROLIFERATING EMBRYONIC (FETAL) ADENOMA

Case XXIX (A91228) A man, aged twenty-six, had had a slow growing goiter for three years. Thyroidectomy was performed, a substernal goiter was partially removed. Five hundred fifty grams of tissue were removed. The patient was reexamined one year later. Goiter had recurred seven months after the first operation, producing marked obstruction during the last three months. A second operation was performed one year after the first, death occurred one year and eight months later.



FIG 46 (Case A91228) —A section through the gross specimen. Almost the entire tumor is composed of rapidly growing tissue.

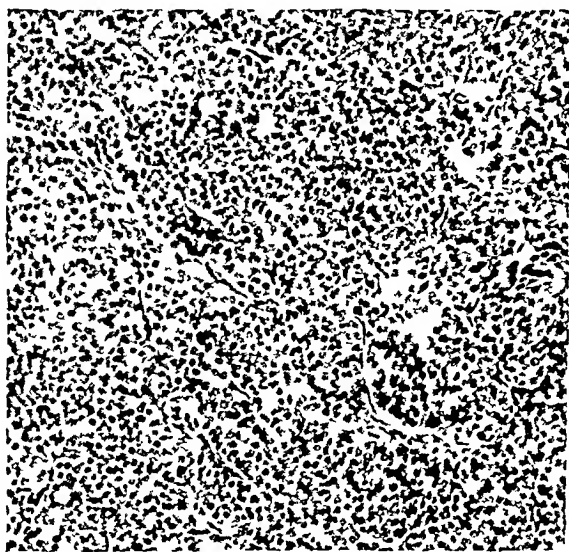


FIG 47 (Case A91228) —A section through the tumor near the capsule. embryonic cells are arranged in feebly demarked lobules. $\times 100$

MALIGNANT TUMORS OF THE THYROID

Case XXX (A23200) A woman, aged thirty-seven, had had goiter for twenty-nine years. A hard tumor of the right lobe of the thyroid was enucleated. The center of the tumor was broken down. One hundred eight grams of tissue were removed. The patient was reexamined seven years after the operation. The left lobe of thyroid was slightly enlarged. There were no symptoms. The patient was in excellent health eleven years after the operation.



FIG 48 (Case A23200) —A section through the gross specimen showing well encapsulated adenoma with degenerating center marked fibrosis and some hyalinization, only small areas showing active growth

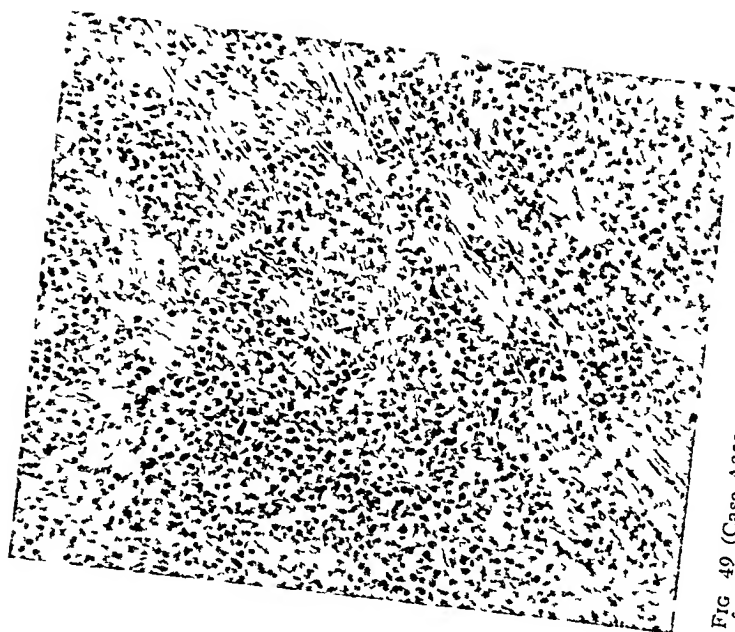


FIG 49 (Case A23200) —A section through the edge of an apparently actively growing area. Embryonic epithelial cells enmeshed in fibrous connective tissue. X100

NON-MALIGNANT ADENOMA

Case XXXI (A28462) A woman, aged sixty-five, had had a gradually growing goiter for thirty years. A cystic adenoma of the left lobe was enucleated. Five hundred twenty-four grams of tissue were removed. The patient has remained perfectly well during the eleven years since operation.

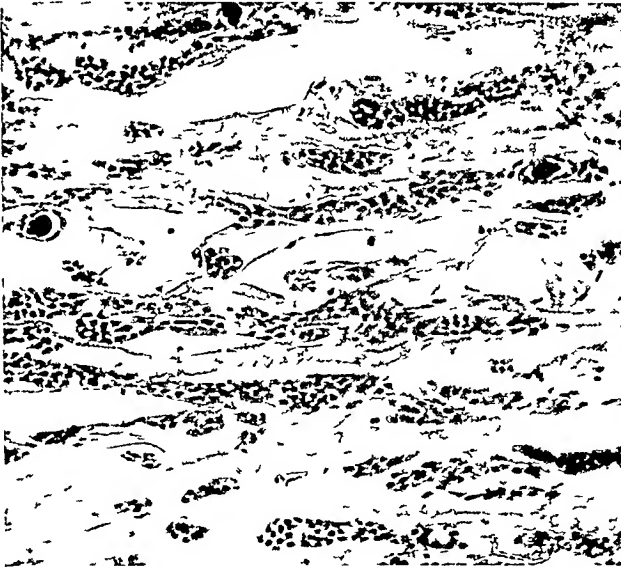


FIG 50 (Case A28462) —A section through the outer portion of the thick cyst wall showing embryonic cells enclosed in heavy bands of fibrous connective tissue. $\times 100$

MALIGNANT TUMORS OF THE THYROID

Case XXXII (A77623) A woman, aged forty-one, had had goiter for fifteen years without recent accelerated growth. A cystic adenoma of the right lobe was enucleated. Fifty grams of tissue were removed. The patient reports that she is in perfect health with no local recurrence of tumor up to eight years after the operation.

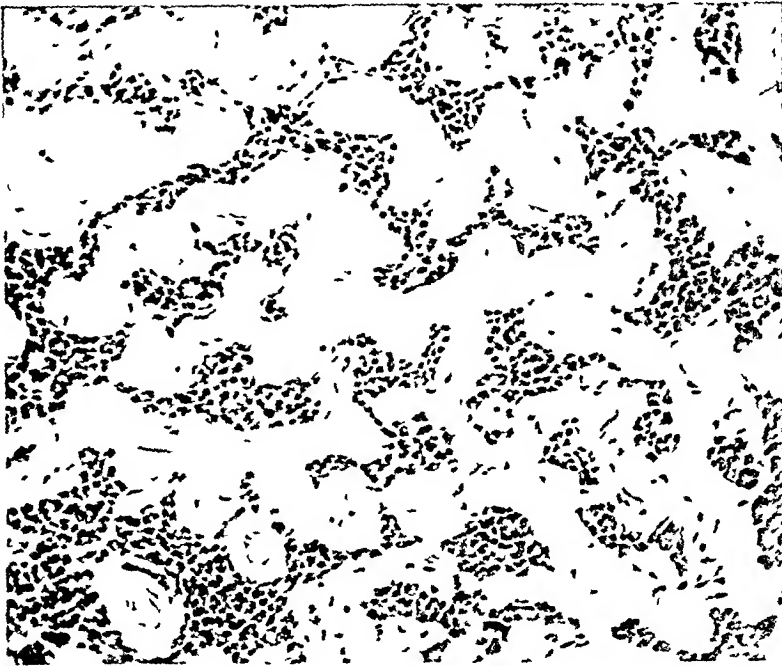


FIG. 51 (Case A77623) —Small embryonic cells in the broad bands of hyaline connective tissue. $\times 100$

NON-MALIGNANT CYSTIC DEGENERATING ADENOMA

Case XXXIII (A93491) A woman, aged twenty-two, had had goiter for two and one half years. A cystic degenerating adenoma of the left lobe of thyroid was enucleated. Sixty grams of tissue were removed. The patient is in good health without local recurrence seven years after operation.

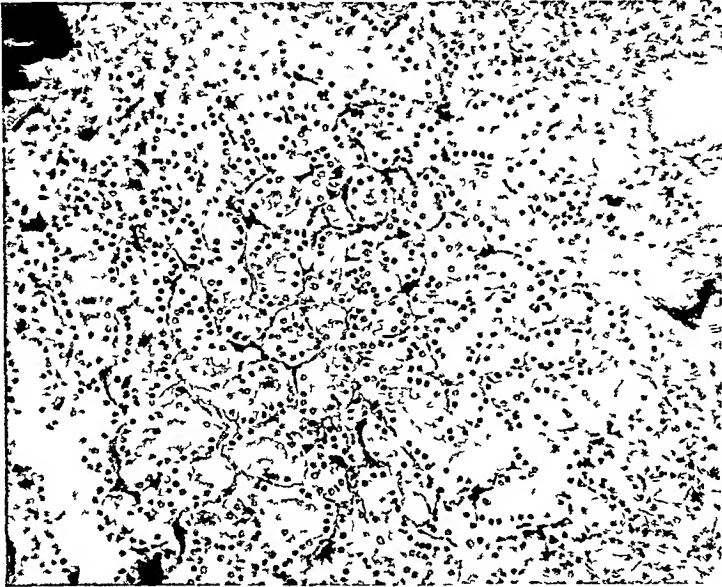


FIG 52 (Case A93491) —A section through the wall of the cystic thyroid showing degenerating epithelial cells with granular protoplasm and shrunken nuclei arranged in well defined lobules. $\times 100$

MALIGNANT TUMORS OF THE THYROID

DEGENERATING CALCAREOUS ADENOMA

Case XXXIV (A100637) A man, aged forty-nine, had had goiter for one and one-half years. The right lobe and isthmus were extirpated and a calcareous adenoma involving almost the entire right lobe of the thyroid was enucleated. The right lobe projected a few inches beneath the sternum. One hundred forty grams of tissue were removed from the right, and sixty grams from the left. The patient is alive and well with no local recurrence up to six years after operation.

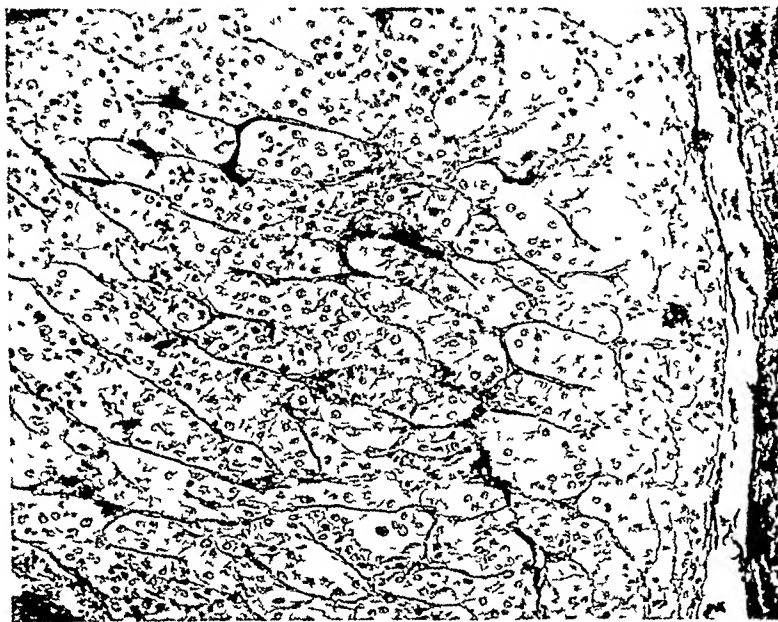


FIG. 53 (Case A100637) —A section through the periphery of the adenoma including the capsule near the calcified area degenerating epithelial cells in well-marked lobules. X100

DOUBTFUL

Case XXXV(A30296) A woman, aged twenty-eight, had had goiter for twenty-one years. It had not caused trouble until six years before. The growth had been rapid during the past two years. She had lost ten pounds in weight in the past year. The right lobe and isthmus were extirpated. One hundred fifty-six grams of tissue were removed. The patient returned for examination eight months after the operation. The goiter had markedly increased in size. The left lobe was resected. One hundred twenty grams of tissue were removed. The patient was examined five months after the second operation. She was complaining of choking, palpitation and dyspnoea, and had lost weight during the last week. Two and one-half years after the second operation she reported that she was the same as when last examined, still had a choking feeling but was not losing weight. Seven years after operation she was still having trouble with breathing, but felt better. Ten years after operation she reported no definite symptoms of recurrence, her general health as good.



FIG. 54 (Case A30296) —A section through the right lobe of the thyroid showing small adenomas included in apparently normal tissue

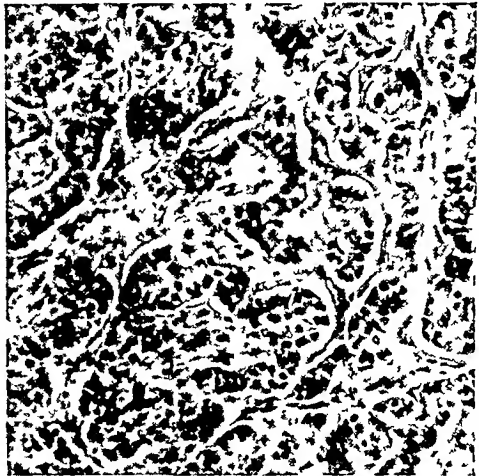


FIG. 56 (Case A30296) —A section through another small adenoma shown in Figure 54 showing partially differentiated embryonic epithelium in lobules between heavy bands of fibrous connective tissue. At first sight this looks like an infiltrated carcinoma. $\times 103$

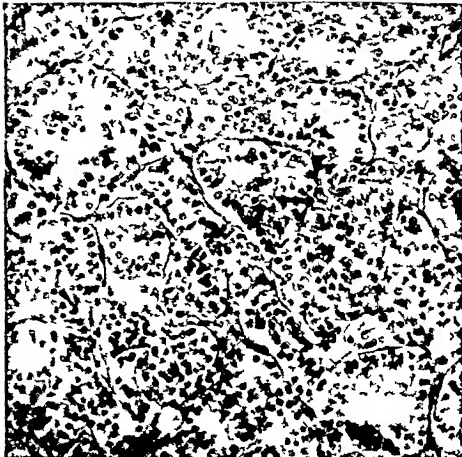


FIG. 55 (Case A30296) —A section through one adenoma shown in Figure 54 showing partially differentiated embryonic epithelium in well marked lobules several of which contain colloid. $\times 103$

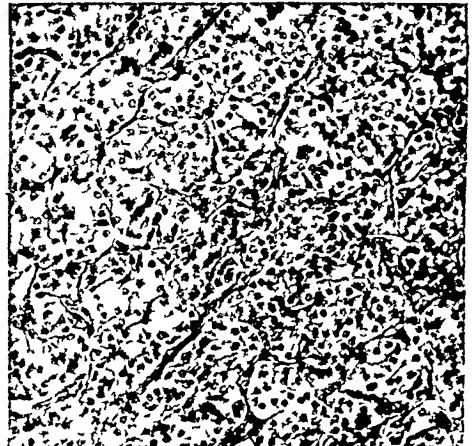


FIG. 57 (Case A30296) —A section through an adenoma removed at the second operation fairly well differentiated embryonic epithelium arranged in lobules with well marked vessels between. $\times 100$

MALIGNANT TUMORS OF THE THYROID

PROLIFERATING ADENOMAS (WUCHERENDE STRUMA, LANGHANS)

A careful study of a large series of tumors of the thyroid leads inevitably to the conception of the very important part played by proliferating adenomas as the starting point of malignant tumors of finally varying histologic types. This has been shown in the preceding illustrations of specimens from illustrative cases. We are indebted to Langhans for the first detailed description of proliferating adenomas, although they had been observed previously by von Eiselsberg, Erdheim and many others. Langhans' description is so good that one cannot do better than to repeat it in part. The reader should compare the description with the preceding illustrations, particularly Figures 41 to 49 for embryonic types and Figures 36 to 40 for more differentiated types.

"Microscopically wucherende Struma forms large encapsulated, roundly oval or somewhat flat nodules which may reach a diameter of ten or fifteen centimeters or more. The surface is smooth or has flat projections which are attributable to its lobular structure. The lobules have a diameter of one to two centimeters and are divided from each other directly under the capsule by penetrating fibrous septa, toward the interior they often run together, the septa become perforated. Sometimes they (the septa) are very little developed in the periphery and are suggested only by indentations. In the centers of the nodules there are very often found more or less extensive loosely built connective tissue, somewhat stellate cicatrices. The neoplastic tissue is soft, often hypertrophic, of only medium transparency, and according to the blood content gray, red or pale. The surface of the cut section is smooth or slightly granular.

"The epithelial masses, in fifteen micron sections, show uniform cloudy, finely granular protoplasm with very dense round nuclei. Red outlines between the nuclei are to be seen only in places where they are further separated from each other. In thinner sections the cell outlines can be seen more easily, particularly with oil immersion lenses. The nuclei are round or slightly oval, the smaller ones measure six to eight microns, the larger ones ten and often fifteen microns. The latter usually show a distinct eosin-red nucleolus. The number of chromatin granules and threads is moderate. The nuclei in general are very numerous and are in contact with each other or separated by only a small fraction of their own diameters. There are also, not rarely, small dark nuclei which are usually lying singly between the other nuclei in varying numbers in the younger parts of the tumor as well as in the center in which they are even more frequent. In the region of the central loose "cicatrix" they are particularly abundant. They also show small clumped, poorly preserved mitoses.

"This nuclei-rich protoplasm is divided by septa, of only blood-vessels with sinus-like lumina, into smaller subdivisions. Between the septa and the epithelium is usually a space, probably the result of retraction of the protoplasm and collapse of the vessel walls. The subdivisions are polyhedral, roundish compartments or long band-like strips.

"The compartments are developed equally in all directions and have a diameter of 200 to 500 microns or even smaller. The majority are very regularly polyhedral with rounded corners. When sections are made radially or parallel to the capsule, the picture is the same. Therefore, they are not cord-like structures but are closed off from one another, in this respect being repetitions of normal thyroid vesicles on an enlarged scale.

"The band-like strips vary in their width more markedly than the compartments. Their width is usually less than the diameter of the compartments, 100

microns or less. Rarely have they even five densely arranged nuclei in their transverse diameter. All that are vertical to the capsule of the tumor are parallel to each other and can be easily traced from one to several millimeters, in the depths they are bound by transverse and oblique short branches.

"Compartments and bands may be present in combination. In such cases the bands have a very irregular course, being wound in all directions. The compartments may also be very various, they acquire semicircular sinuosities, become rosetted, or form papillæ like and finger-like processes, coming out from one or several sides.

"The wide septa through the lobules are essentially fibrous.

"The septa between the epithelial compartments and bands have a very characteristic structure, which is always repeated in the metastasis, and because of that fact one may make a positive diagnosis from a small portion. They are made up of vessels with mere capillary walls. Often there is a loose fibrillary adventitia. Their form is likewise characteristic of these vessels. Only very rarely does one see the transverse section of the vessel or a round group of nuclei which might correspond to the endothelium of a collapsed vessel. Always visible luminae are cleft-formed and a good many of the polyhedral fields have on each side a single such lumen which gaps more or less widely. It is a markedly flattened sinus like vessel resembling in some respects the blood-vessels of many sarcomas which also form small spindle shaped or stellate clefts.

"Normally there may be smaller lacuna-like formations, 'sinusoids'.

"Stages are noted in which all of the previously solid compartments and bands have been changed to numerous small round gland vesicles. Often the vesicles are so dense that one can see the dividing septa only on high magnification. The septa having been changed they now are nucleolar instead of solid cell masses, a number of pure epithelial hollow spheres, each one of which is surrounded by only one layer of cells which lie more or less loosely near each other and without any vessel-containing septum between them. These pictures are particularly important.

"Colloid is found even in the gland vesicles, first in the form of a uniformly small line stained with eosin which outlines the protoplasm from the luminae, or in the form of a crescent which fills one-half or two-thirds of the lumen and with its pointed ends surrounds the entire periphery of the latter.

"Therefore, in the final stage of the process a new tissue is built that greatly resembles normal thyroid tissue and still more accurately resembles the tissue of a colloid Struma. Therefore, for wucherende Struma the first stage of the large solid cell masses and the final stage of groups of loosely lying gland vesicles without dividing septa are of great importance.

"I have assumed that the earlier stages are on the periphery and the later ones in the center of the nodule.

"In wucherende Struma we have a structure which in its regularity recalls a normal organ that is undergoing development, in the periphery the solid cell mass which disintegrates toward the interior into smaller cords and then into gland vesicles with one-layered epithelium and sometimes with colloid. We have, therefore, a tissue that is constantly being transformed. In addition we have a vessel with a characteristic form, arrangement, structure of walls and relationships to epithelium. In its architecture, wucherende Struma resembles the normal organ much more than it resembles carcinoma.

"Is it formed, as is assumed to be the case in all malignant struma, on the basis of colloid nodule which suddenly begins to grow and increases in size and in consistency only as a result of severe stretching of the capsule? I have seen

no pictures which proved the origin of neoplastic cells from the epithelial cells of the gland vesicles. The general theory regarding the origin of malignant strumæ from accompanying colloid strumæ finds no basis in my investigations. The facts can

MALIGNANT TUMORS OF THE THYROID

be better understood if we assume that the wucherende Struma is such from the very beginning, that even in the earliest stages it consists of solid cell masses and that therefore it is to be traced back to that fetal period in which no gland vesicles had been formed and only solid cell masses are present. The process which takes place in wucherende Struma is certainly an incomplete parallel to that of the normal development of the thyroid. You may regard it as a delayed development from fetal rests."

BIZARRE GROWTHS IN DISTANT ORGANS

Previous observers have noted the occasional occurrence of malignant tumors composed of thyroid tissue growing in regions distant from the thyroid with total absence of any appearance of malignant tumor in the thyroid itself. The series of 290 cases herewith presented contains only one case of this kind (Case A300801), a woman, aged thirty, who came to the Clinic with a history of periodic hæmoptysis—"vicarious menstruation." Röntgenograms showed a right-sided mediastinal tumor about 7 cm. in diameter, not connected with the circulatory mechanism. A provisional diagnosis of intra-thoracic thyroid was made. Operation was refused. Thyroxin was administered and very effectively controlled the hemorrhages for six months, after which time they recurred. The patient returned for examination one and one-half years after she was first seen. The tumor had materially enlarged and the patient was *in extremis*. The mediastinum was explored but no attempt was made to remove the growth. The patient died one week later. At necropsy a tumor of thyroid tissue of the embryonic adenoma type, 7 cm. in diameter, completely encapsulated, and encroaching on the right bronchus was found. The thyroid itself was normal except for one small degenerating adenoma, about 1 cm. in diameter, which did not appear to be malignant. Tumor tissue was not found elsewhere in the body. This was apparently an instance of the overgrowth of fetal tissue which had probably been misplaced into the lung in the embryo.

Not rarely the epithelial cells in the thyroid tissue of metastases are not in the same stage of development as that in the original tumor in the thyroid. A good illustration of this is found in Case A355859, of the series of 290 cases, a man, aged sixty-two, who came to the Clinic *in extremis* and died two days afterward. Necropsy showed the lungs, pleura, liver, and abdominal lymph nodes filled with extensive metastatic deposits of tumor tissue, the cells of which in their size, staining and arrangement resembled those in proliferating fetal thyroid. The thyroid itself was the site of an extensive malignant tumor, most of the tissue of which was composed of cells fairly well differentiated toward the adult type.

RECURRING THYROID TUMORS OF DOUBTFUL MALIGNANCY

The series of 290 cases contains three or four instances of young persons with rapidly proliferating tumors of the thyroid which histologically are either fetal or partially differentiated adenomas which recur rapidly and extensively and yet throughout long periods show no signs of metastasizing (Case XXXV (A30296) Figs 54 to 57). One should be warned in diagnosing the

condition shown in Figure 56, an infiltrating adenocarcinoma. The histology of the tumors in the other cases usually resembled that shown in Figures 55 and 57, but though recurrences have been frequent throughout periods of from eight to fourteen years, there is still no evidence of metastasis.

HYALINIZATION, FIBROSIS, CALCIFICATION AND HYDROPIIC DEGENERATION

There can be no question but that many proliferating embryonic adenomas, which apparently start on their way toward malignancy, become impeded in their active overgrowth, reduced and finally degenerate, either by hyalinization, fibrosis, calcification or hydropic change. Good illustrations of this are seen in Cases XXX to XXXIV (Figs 48 to 53), in which the relative amounts of connective tissue and parenchyma should be noted, as well as the cells with small, cramped, irregular nuclei without mitosis. The pathologist must take this possibility into account in his advice to the surgeon, but a proliferating adenoma in a patient of cancer age should not be considered benign unless the process of degeneration is very extensive and thoroughly overbalances the proliferation. The gross appearance of the tumor, the thickness and integrity of the capsule, the relationships of the capsule and fibrous septa to the parenchyma, the presence or absence of hyalinization, fibrosis, calcification and anemic or hydropic degeneration, the character and arrangement of the parenchymal cells, and the presence or absence of mitotic figures must all be taken into account.

SUMMARY

1 The paper presents an analysis of the literature and a summary of the data on 290 patients with malignant tumors of the thyroid who have been examined in the Mayo Clinic up to December 31, 1920.

2 Malignant tumors of the thyroid are much more frequent than is generally believed. Their correct clinical diagnosis is frequently missed (a) because they may have periods of development of from five to fifteen years and patients are not followed up long enough after operation, and (b) because not infrequently the tumor in the thyroid itself is relatively small and the character of metastasis is not determined, owing to the rarity of necropsies.

3 Pathologic diagnosis is difficult owing to the great variation in the histology of the tumor tissue and its resemblance to that of non-malignant processes.

4 There has been a marked failure of American surgeons to report in the literature their cases of malignant tumors of the thyroid, this should be corrected.

5 Insufficient observations are at hand for determining the geographic incidence.

6 The age incidence at the date of diagnosis is greatest in the fifth decade.

7 The distribution by sex is about one man to two women.

8 Patients usually seek medical advice on the occasion of recent rapid growth in a long-standing nodular tumor of the thyroid. Some give histories of slow continuous growth.

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9 Early thorough operations give a fair percentage of cures Palliative operations in late cases with extensive local involvement are warranted

10 Pathologic diagnosis must take into account the usual development of malignant tumors of the thyroid from proliferating embryonic adenomas

11 A series of photographs of specimens, gross and microscopic, of thirty-five illustrative cases is presented with brief clinical and pathologic notes to serve as an atlas in assisting the pathologist in diagnosis

12 The pathologist must be thoroughly familiar with the characteristics of proliferating adenomas, as first described by Langhans, in all their stages

13 The pathologist must be on the lookout for the possible relationship of bizarre metastatic growths of tumors of the thyroid

14 The pathologist, in his diagnosis for the guidance of the surgeon must consider the relative preponderance of proliferative and degenerative processes in the tumor, but a proliferating adenoma in a patient of cancer age should not be considered benign unless the process of degeneration is very extensive and thoroughly overbalances that of proliferation

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CLINICAL EXPERIENCE WITH SYNERGISTIC ANALGESIA

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THE object of the research upon which this report is based was to find a more satisfactory method of inducing and maintaining analgesia and anæsthesia than exists at present. The fact that so many surgeons are using local, sacral, or spinal analgesia would seem proof to even the casual observer that the present methods are not satisfactory. From the introduction of ether and chloroform to the present time, surgeons and anæsthetists have been prone to contend for one anæsthetic or method, in preference to using a combination of anæsthetics or methods. This uncompromising attitude is well illustrated by the fact that in the Massachusetts General Hospital chloroform anæsthesia is practically never used, while in some parts of Scotland nothing but chloroform is used. If Sir James Y. Simpson had successfully demonstrated chloroform in the Massachusetts General Hospital and if Morton had successfully demonstrated the use of ether in Scotland, the situation would probably be reversed today. Advocates of "straight" nitrous oxide and oxygen anæsthesia are probably responsible for more deaths than are the advocates of any one anæsthetic or single method. Advocates of "straight ether" are entirely responsible for the unsavory reputation of ether. When a patient is saturated with nitrous oxide, with sufficient oxygen to maintain a satisfactory anæsthesia, he is bordering on or may be in the danger zone, and the next step will be respiratory arrest and death.

When a patient is saturated with warm oxygenated ether vapor (the safest and best method of administering ether) to the same degree of relaxation as one saturated with nitrous oxide and oxygen, he is much further removed from the danger zone than is the nitrous oxide and oxygen patient. If a sedative, such as morphine, is given as a preliminary, and if the anæsthesia is intelligently continued by the administration of either nitrous oxide and oxygen or ether, the patient is immediately removed much further from the danger zone. If now the patient is given the highest possible safe physiological dose of morphine (average adult grain) and the nitrous oxide and oxygen administered only for unconsciousness, the patient is separated from the danger zone by the second and third stages of anæsthesia, *i. e.*, the patient is held between A and C, as represented in the following chart, which shows the comparative safety of the methods just described.

SYNERGISTIC ANALGESIA					Nitrous oxide and oxygen	
					anæsthesia alone	
A Analgesia	B 1st stage	C 2nd stage	D 3rd stage	E Danger	Zone	F G
A	Commencement of anæsthesia					
A B	Analgesia					
B C	First or excitement stage					
C D	Second stage					
D E	Third or surgical stage—the usual stage in which operations are performed with inhalation anæsthesia					
E F	Danger zone					
F	Respiratory arrest					
G	Death					

The difficulties experienced with the usual inhalation anæsthesia are the lack of relaxation essential for many surgical procedures and the after-effect of nausea, vomiting, and gas pains, induced by the morphia. By the addition of magnesium sulfate to the preliminary morphine medication, a better relaxation is obtained and the nausea, vomiting, and gas pains are much reduced, if not entirely eliminated. If, on the other hand, no allowance is made by the anæsthetist, and if a state of anæsthesia is superimposed upon the state induced by preliminary medication, the patient is immediately plunged into the danger zone and possibly into a condition of shock from the inhalation anæsthetic. If the same degree of relaxation can be obtained with perfect safety by transferring the patient to the first stage of inhalation anæsthesia, thus removing him from the danger zone by two stages, one should not hesitate to abandon the established ideas of anæsthesia, and to accept the new method, *i. e.*, analgesia with unconsciousness. This condition is approximated by using morphine with magnesium sulfate as the analgesic, and inducing unconsciousness with nitrous oxide and oxygen.

In a previous paper¹, it was stated that when magnesium sulfate, 1 to 2 cc (25 per cent chemically pure), is used with morphine— $1/12$ to $3/8$ grain—instead of plain water, and given by hypodermic, the value of the morphine is increased 50 to 100 per cent, that is, "one hypodermic will do the work of from two to four." This was illustrated by stating that this hypodermic "will abolish pain for two, three, or four times as long as morphine given alone." This fact was obtained from bedside observation and can be easily verified by any one using magnesium salts 25 per cent C P instead of sterile water with morphine for the relief of pain. But $1/8$ is not made equivalent to $1/6$ gr or $1/6$ to $1/4$, or $1/4$ to $1/2$, or $3/8$ to $7/8$. By either increasing or repeating the dose of morphine with sterile water, its action is intensified but not prolonged, as when used with the magnesium salts. Furthermore, when the morphine with sterile water is repeated the possibility of nausea, vomiting, and gas pains is very greatly increased. Cushny² states, "Its (morphine) injection is occasionally followed by some nausea, *which is much more fre-*

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quently present during recovery from the drug" Evidently the effect of the magnesium salts abolishes this late untoward effect of morphine. It is well known that the preliminary administration of morphine abolishes the excitement or struggling stage and is a potent factor of safety, since over 90 per cent of all deaths occur in the first five minutes of any inhalation anaesthesia. This preliminary medication renders the anaesthesia easier, smoother, and safer. The nausea and vomiting, as already stated, come on later, and sometimes are most disastrous. In favor of morphine, Cushny² states "It has little direct action on the circulation in man, the blood pressure remains high. It is not contra-indicated in Bright's disease of the kidney, as it is not excreted in the urine." Meyer and Gottlieb³ state. "Perception of pain is diminished by doses which scarcely affect the motor centers, and which have no appreciable influence on the perception of ordinary sensations." These observers hold that "scopolamine is not an analgesic, and yet the combined administration of small doses of morphine and small doses of scopolamine, which by themselves produce hardly any effect, results essentially in an exaggeration of the effects of morphine." The synergism of morphine and scopolamine, morphine and atropine, and morphine with all the general anaesthetics is well known. The synergism of morphine, and magnesium sulfate is now partly understood. The prolonged analgesic effect, with absence of untoward effects, such as abdominal distention, headache, and post-anaesthetic vomiting, constitutes a distinct advance in the technique of anaesthesia.

The possible explanation of the increased value of morphine, may be that the magnesium simply holds the morphine in contact with the nerve tissues longer than the morphine can retain that contact alone, or we may assume that each of the agents used affects in a different way the same part of the central nervous system, or that each of them has an affinity for special nerves or centers, and that the combined result or synergism is safer and at the same time more powerful than that of any one of them used alone.

Whether the above explanations are or are not correct, the fact of the increased value of morphine with magnesium sulfate can be easily verified or disproved.

The following case illustrates the prolonged effect of morphine when used with minimum amounts of magnesium sulfate and is taken from the service of Dr. A. V. S. Lambert at the Presbyterian Hospital, New York, N. Y., as are all the other cases reported in this paper.

No. 46241 F—Badly lacerated wound of leg, gas infection, opened wide December first, gastrocnemius severed.

					Duration, hours	
2nd	1 15 A M	Morphia 1/5	MgSO ₄ , 2cc	25%, quiet until 5	5¾	
	6 15 A M	Morphia 1/12	MgSO ₄ , 2cc	25%, no pain all day	18	
	The magnesium was now discontinued Morphine alone used					
3rd	1 30 P M	Morphia 1/6,	pain in two hours		2	
	3 25 P M	Morphia 1/6,	pain at 6 40		3¼	
	The magnesium was again added to the morphine					
	6 55 P M	Morphia 1/6,	MgSO ₄ 25%, 2cc	No pain till next day	23	

4th	5 00 P M	Morphia 1/10 MgSo ₄ , 2cc	25%, no pain till next A M	17
5th	10 15 A M	Morphia 1/10 MgSo ₄ , 3cc	, 25%, quiet all day	10
	8 15 P M	MgSo ₄ 3cc	, very good night	19
6th	3 50 P M	MgSo ₄ 3cc	, 25%, severe pain after 3 hours	3
	6 15 P M	Morphia 1/8 MgSo ₄ 2cc	, 25% jerking of leg in 2 hours	2
	9 15 P M	Morphia 1/8 MgSo ₄ 2cc	, 25% quiet night	19

The patient required one hypodermic of morphia 1/10 to 1/6 and MgSo₄ 2cc 25% each day after this until December 13th Codeine and morphia alone did not give relief

In the paper already referred to, it was stated that "Magnesium sulphate (from 6 to 15 cc) given by hypodermic injection two hours before operation, followed by morphine sulfate hypodermatically (from 1/12 to 3/8 grain) one hour before the operation, when supplemented by nitrous oxide and oxygen (the oxygen being employed in a much higher percentage than usual) gives a safer and better relaxation than when ether is used"

While the magnesium sulfate synergizes with the morphine, prolonging its action, it *deepens the action of the nitrous oxide*, thus permitting the maintenance of a satisfactory narcosis without the use of ether We now use 30 to 50 cc of a 25 per cent solution of magnesium sulfate, this is diluted with sterile water, q s, 300 to 500 cc, and given as a hypodermoclysis—starting two hours before and finishing one and a half hours before the time for operation The morphine is given in 1/8-grain doses, hypodermatically, at twenty to thirty minutes intervals—the first dose being given one and a half hours before the operation Three-eighths of a grain is the usual amount If an idiosyncrasy is present, it reveals itself before the time for the third dose, the patient being thus safeguarded from an overdose

Where great relaxation is not required, 1/8-grain of morphine in 1 to 2 cc of magnesium sulfate, repeated twice, and supplemented by nitrous oxide and oxygen, is sufficient for a satisfactory narcosis, *i e*, the patient is perfectly quiet and is pink at all times

We started with the supposition that it was best for the patient to be conscious, if possible, during an operation and that robbing him of consciousness was in itself somewhat of a shock The patients themselves, however, have compelled us to reverse this opinion The majority of them prefer to be unconscious during an operation of grave import On this point Keen⁴ states "The ideal anæsthetic will not be one which will abolish pain without abolishing consciousness To have the patient aware of surgical emergencies which test even a veteran operator's skill and resources to the utmost would frequently invite death by the terror which it might occasion The ideal anæsthetic will abolish pain by the abolishment of consciousness, but without danger to life"

Whether conscious or unconscious, however, the patient is better protected from pain impulses by the use of some local analgesic with all anæsthetics, since neither morphine, magnesium sulfate nor nitrous oxide and oxygen, ether nor chloroform seem to have any effect upon the cutaneous nerves, except when administered to the point of saturation

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Cushny² holds that "The peripheral muscles and nerves are unaffected by morphine in any except overwhelming doses" The following cases indicate both the amount and the time, as well as the effects, of the synergistic method

CASE I—*Carcinoma of rectum*—Sacral approach—removal of lower part of sacrum and coccyx

Male, age sixty-one (48230), large, heavy, chronic aortitis and chronic bronchitis

6 30—10 cc $MgSO_4$ 25 per cent subcutaneously

7 00— $MgSO_4$ 15 cc Morphia gr $\frac{1}{8}$, Chloretone supp gr x

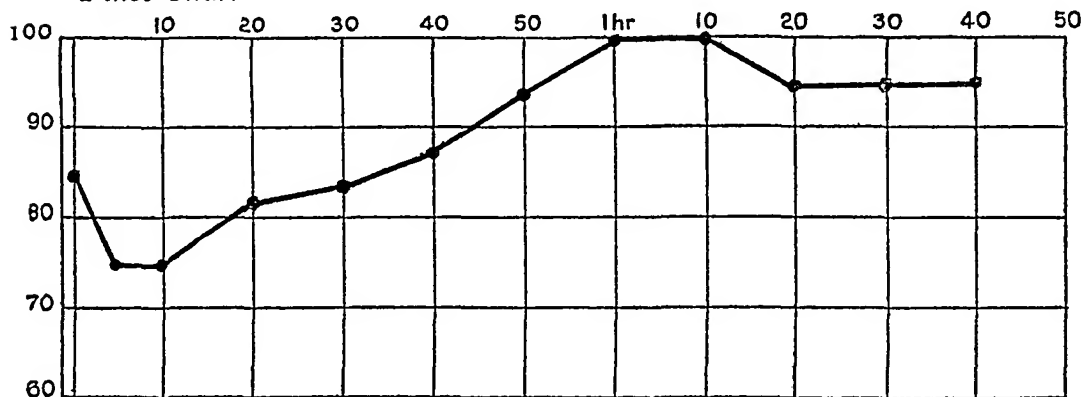
7 30— $MgSO_4$ 15 cc Morphia gr $\frac{1}{8}$, Chloretone supp gr x

8 00— $MgSO_4$ 15 cc Morphia gr $\frac{1}{8}$

Operation 8 50 to 10 20

N_2O and O_2 administered

Pulse Chart



6 Hours post-operative Pulse 96 }
Respiration 16 }

10 Hours post-operative Pulse 90 }
Respiration 20 }

Remarks Patient had wonderfully good effects from above medication Relaxation good Breathing as in natural sleep Amount of gas decreased, and oxygen increased Pulse good and full throughout Respiration normal No nausea No vomiting No sedative until next day, 12 45 P M

CASE II—*Carcinoma of rectum*—*Excision of rectum and colostomy*

Female, age forty-three (48384), small anæmic woman, poor surgical risk, apprehensive before operation

7 30 A M 12 cc 25 per cent $MgSO_4$ subcutaneously

8 30 A M Morphia gr $\frac{1}{8}$, Chloretone suppository, gr x

8 50 A M Morphia gr $\frac{1}{8}$

9 10 A M Morphia gr $\frac{1}{8}$

Operation 9 47 to 11 28

8 Hours post-operative Pulse 108 }
Respiration 12 }

12 Hours post-operative Pulse 122 }
Respiration 24 }

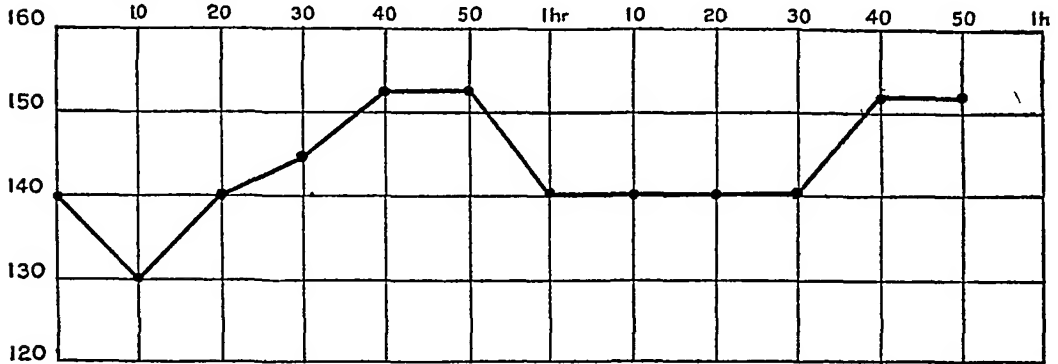
Pulse before operation 140

Pulse during operation 140 to 152

Pulse after operation 130 to 152

Remarks Respirations were 8 before abdomen was opened, kept up to 16 during abdominal work, but fell to 6 during closure of wound. Respirations again stirred up by perineal work, and fell again at end of operation. Respirations 10 when leaving operating room. Excellent analgesic effect. Perfect relaxation. No nausea. No vomiting.

Pulse Chart



Infusion 1200 cc normal saline during operation and transfusion, 500 cc of blood at 3 30, as a prophylactic measure, owing to poor condition of patient before operation and the severe operative procedure. 8 00 P M Pulse 108, respiration 12.

Sedative next day at 2 30 P M Uneventful recovery. This is the first and only case of slowing of respiration and was apparently an idiosyncrasy.

CASE III—Incarcerated inguinal hernia—intestinal obstruction

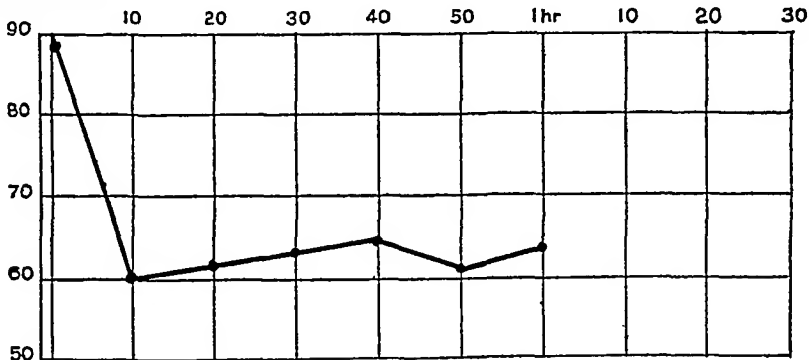
Male, age forty-nine (48129) average build, vomiting before operation.

11 20 P M $MgSO_4$ 4 cc 25% morphine gr $\frac{1}{6}$ by hypodermic

11 35 P M $MgSO_4$ 4 cc 25% morphine gr $\frac{1}{6}$ by hypodermic

Operation 11 50 to 12 45. Anaesthesia gas and oxygen. Good relaxation, no ether required. Slight nausea, vomited 60 cc brownish fluid. Slept all night—medication required morphia gr $\frac{1}{5}$ the next night.

Pulse Chart



8 Hours post-operative Pulse 68 }
Respiration 28 }

12 Hours post-operative Pulse 64 }
Respiration 24 }

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CASE IV — *Acute appendicitis*

Male, age eighteen (48189) nephritis and acute rhinitis

11 35 P M 2 cc $MgSO_4$ 25% morphia $\frac{1}{12}$ by hypodermic

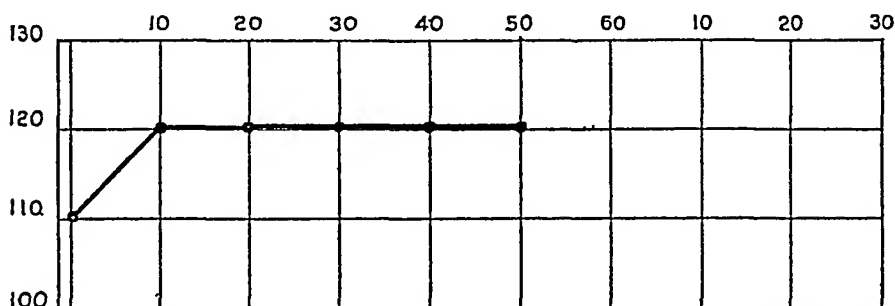
11 50 A M 2 cc $MgSO_4$ 25% morphia $\frac{1}{12}$ luminal gr 1 by mouth

12 05 P M 2 cc $MgSO_4$ 25% morphia $\frac{1}{12}$

Operation 12 25 to 1 34

Novocain—later— $N_2O + O_2$

Pulse Chart



7 Hours post-operative Pulse 124 }
Respiration 30 }

11 Hours post-operative Pulse 120 }
Respiration 24 }

Remarks Anæsthesia, novocain and nitrous oxide and oxygen. Skin incision made without anæsthetic. Novocain necessary in lower muscle layers. Continuous pain after getting into peritoneum. Gas-oxygen given, very good relaxation with low per cent of gas. No nausea. No vomiting. Sedative 1 45 A M next night.

In each of the above cases the surgeon stated that the relaxation was very much better than in similar cases when no magnesium sulfate was used and was comparable to the relaxation under full ether anæsthesia.

The next few cases illustrate the use of $MgSO_4$ and morphine alone, with local analgesia for the skin.

CASE V — *Direct Hernia*

Male, age thirty-three (48343), strong robust young man

7 40 A M $MgSO_4$ 25 per cent 25 cc subcutaneously

8 00 A M Morphia gr $\frac{1}{8}$

8 20 A M Morphia gr $\frac{1}{8}$

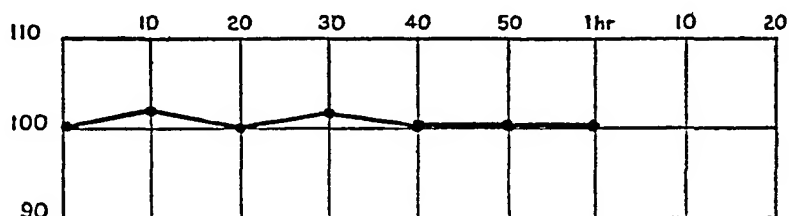
8 30 A M Chloretone suppository, gr xv

8 40 A M Morphia gr $\frac{1}{8}$

9 00 A M Morphia gr $\frac{1}{8}$

Operation 8 36 to 10 36

Pulse Chart



6 Hours post-operative Pulse 84 }
 Respiration 24 }
 10 Hours post-operative Pulse 84 }
 Respiration 28 }

Remarks Patient complained of no pain during operation Slight burning noticed twice during closure Facial expression remained placid Skin suture felt like pin-prick Novocain used in skin No nausea or vomiting No sedative at any time

CASE VI — *Herma, direct* Male, age sixty-four (48907), average size and build, tuberculosis of lung

8 30 A M 30 cc 25 per cent $MgSO_4$ subcutaneously

8 45 A M Morphia, gr $\frac{1}{8}$

9 00 A M Chloretone suppository, grs xv

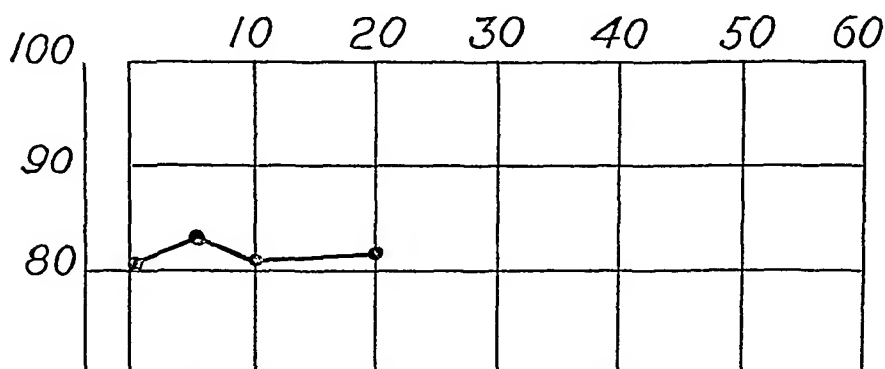
Cannabis indica, po gr i

9 15 A M Morphia hypo gr $\frac{1}{8}$

10 30 A M Morphia, hypo, gr $\frac{1}{8}$

Operation 10 35 to 11 08

Novocain used



6 Hours post-operative Pulse 72 }
 Respiration 20 }
 10 Hours post-operative Pulse 78 }
 Respiration 22 }

Remarks Small amount of novocain infiltration for skin and neck of hernial sac Duration, 33 minutes Remaining procedure painless Complete relaxation No nausea No vomiting No post-operative sedative Pulse 80 at start, rose to 84, and dropped to 72 Pulse 72, respiration 18, on arriving at ward

In not a single instance was there any laxative effect from the magnesium sulphate, and the absence of gas pains was most noticeable The absence of nausea and vomiting in nearly all these cases and the length of time after the operation before a sedative was required, seem to prove (1) That nausea and vomiting are reduced as far as it is possible to do so by the anæsthetic agents, and (2) that the amount of morphine or sedative in any given case is also reduced to a minimum In other words "wound pain" almost invariably

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is a thing of the past, the patients being carried through the pain zone easily and comfortably, without any further administration of morphine

The two following tables, compiled from the charts of the Presbyterian Hospital, would seem to prove this contention

PATIENTS RECEIVING 25% MgSO ₄ (5 TO 30 C C)			
No.	Operation	Sex	Time of post-operative sedative
1	Direct hernia	Male	None
2	Double inguinal hernia	Male	32 hours
3	Carcinoma of rectum	Male	29 hours
4	Carcinoma of rectum	Female	28 hours
5	Acute appendicitis-gen peritonitis	Female	30 hours
6	Incarcerated hernia	Male	24 hours
7	Chronic appendicitis	Female	17 hours
8	Acute appendicitis	Male	13 hours
9	Carcinoma of stomach	Male	13 hours
10	Ischio-rectal abscess	Female	12 hours
11	Chronic appendicitis	Male	12 hours
12	Chronic appendicitis	Male	12 hours
13	Chronic appendicitis	Female	10 hours
14	Chronic appendicitis	Male	5 hours
15	Inguinal hernia	Male	4 hours
16	Lacerated wound of leg	Female	3 hours
Total elapsed time			244 hours
Average time			16 hours, 16 minutes

PARALLEL SERIES OF CASES WITHOUT THE SYNERGISTS

No	Operation	Sex	Time of administration of sedative
1	Ischio-rectal abscess		None
2	Carcinoma of rectum		None
3	Hernia		15 hours
4	Incarcerated hernia		10 hours
5	Chronic appendicitis		3 hours
6	Acute appendicitis		2 hours
7	Chronic appendicitis		6 hours and 12 hours
8	Double hernia	--	3 ¼ hours and 12 hours
9	Left inguinal hernia		3 hours and 10 hours
10	Chronic appendicitis		2 hours and 14 hours
11	Carcinoma of rectum		2 hours and 9 hours
12	Chronic appendicitis		1 ½ hours and 8 hours
13	Carcinoma of stomach		1 hour and 18 hours
14	Acute appendicitis		½ hour, 2, 6 and 12 hours
Total elapsed time			49 ¼ hours
Average time			4 hours, 6 minutes

The average time after an operation for the administration of a sedative is 16 ¼ hours with the synergists and 4 hours 6 minutes without this aid. The patient is comfortable four times as long with the synergists as without them, and receives less morphine.

With the synergists, the appetite is better on account of the absence of wound pain and absence of gas. The normal appetite and absence of gas pain means a marked shortening of the convalescence as well as a much more agreeable one.

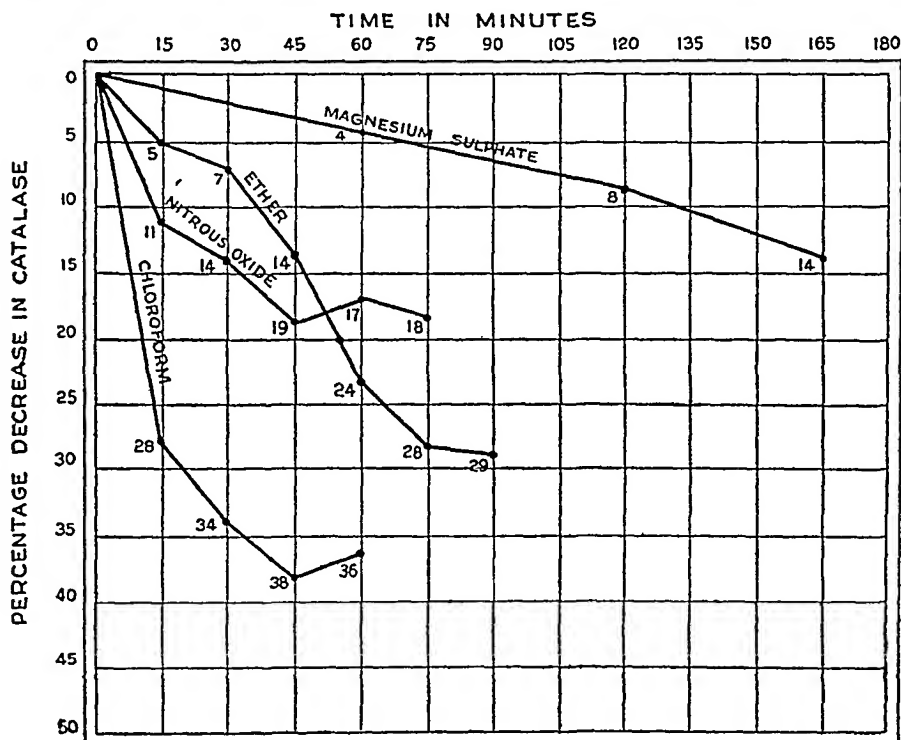
Without the synergists, there were 10 cases requiring supplementary sedatives—not including the first sedative—one of the cases having three

repetitions With the synergists, there were no repetitions within twenty-four hours after the administration of the first sedative

One of us (J G) assisted or operated in the large majority of the cases and can fully substantiate the statement of Lambert that relaxation with nitrous oxide, oxygen, and the synergists is just as good as without nitrous oxide, oxygen, and ether

It may be possible, that with improved technique the total amount of morphine used in any given case may be still further reduced The fact that post-operative nausea and vomiting, and wound and gas pain are practically eliminated, is most important In the light of our present experience, these dreaded sequelæ of the anæsthetic and the operation can be entirely averted

Further illustrating the value of magnesium sulfate, compared with other anæsthetics, W E Burge⁵, working in the Physiological Laboratory of the University of Illinois, to determine how anæsthetics decrease oxidation, found that "Narcotics of widely different constitution, such as chloroform, ether, nitrous oxide, and magnesium sulfate, decrease the catalase of the blood parallel with the increase in the depth of narcosis A very powerful anæsthetic, such as chloroform, decreases the catalase more quickly and more extensively than does a less powerful anæsthetic, such as ether Slowly acting anæsthetics, such as magnesium sulphate, decrease accordingly the catalase of the blood more slowly than a quickly acting anæsthetic, such as nitrous oxide "



While synergistic analgesia—the analgesia obtained by the reciprocal augmentation of the action of drugs upon each other—is still but slightly

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understood, yet the sum total of the results is so overwhelmingly in its favor, as compared with any method of inhalation anæsthesia, that we have no hesitation in submitting these data at the present time

SUMMARY

1 Morphine and magnesium sulfate synergistically used give good relaxation when supplemented with (a) Nitrous oxide and oxygen to abolish consciousness and for its added analgesic effect, (b) Or by using a local analgesic for the skin and peritoneum

2 Nausea and vomiting, wound and gas pain are reduced to a minimum and quite often entirely eliminated

3 When morphine is given as a preliminary to any inhalation anæsthetic, its good effects are observed in the induction, almost entirely abolishing the stage of excitement. The nausea and vomiting occur as the patient is emerging from the inhalation anæsthesia. By using magnesium sulfate with the morphine, the good effects secured in induction are retained, the nausea and vomiting are eliminated, a stage of analgesia being substituted

4 Morphine and magnesium sulfate give relief from pain either immediately post-operative or at other times for a much longer period than morphia alone

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CERTAIN FUNDAMENTAL LAWS UNDERLYING THE SURGICAL USE OF THE BONE GRAFT

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No subject has been discussed more extensively in our recent surgical congresses and clinics than the various uses of the bone graft. The theories advanced as a result of laboratory researches have been many. The amount of literature which has been written on the subject of pseudoarthrosis has been voluminous. Unfortunately, however, for the true solution of this problem, the conclusions offered in many of these discussions and reported experimental findings have been immature, or based upon false premises, or upon meagre inadequate observations, and the information presented consequently misleading. This has been due, no doubt in part, to the exigencies of the times and to the necessity in our military services of calling upon the assistance of men never heretofore interested in this work, or those frequently, alas, unqualified by experience or by mental training and adaptability to do justice to these serious problems. As the necessity of the proper observance of fundamental biological, physiological and mechanical laws is more strikingly illustrated in the application of the graft to pseudoarthrosis than any other, the discussion in this paper will largely centre around this subject, although it will apply equally in the use of the graft for any purpose whatsoever.

In the entire realm of surgery there is today no subject of more intense interest to the profession, nor of greater importance to the patient himself, than a consideration of the proper treatment of pseudoarthrosis, with or without loss of bone. The treatment of this stubborn condition centers almost exclusively about the employment of the bone graft. The great numbers of such unfortunate cases resulting from traumata of the recent war have emphasized the seriousness of the situation. In France alone, the author was recently informed, there are over 20,000 cases of pseudoarthrosis awaiting operation. All of which originated in the great war. No estimate has been attempted in the United States, but undoubtedly the number in this country is very great, especially if ununited fractures of the hip are included.

Among the great variety of methods which have been tried in the past in the correction and treatment of pseudoarthrosis have been included numerous experimental attempts to stimulate bone growth, such as the injection into the site of the lesion of blood taken from another part of the patient's body, the Bier hyperemia, deep massage to promote healthy circulation, or the internal administration of medicaments. Triple calcium phosphate has been used by the author locally in early cases with success (see Albee, ANNALS OF SURGERY, January, 1920). In cases of pseudoarthrosis of the tibia or femur, various modes of bracing the lower extremity

have been tried, with the purpose of allowing weight-bearing and function to exert a special stimulus to bone proliferation

Operative measures have also been attempted in the treatment of this condition, such as plastic procedures on the bone fragments themselves, consisting of "step-up" operations, in which the freshly cut bone of the fragment ends were brought together. In other plastic work, the fractured fragments have been brought into closer apposition, with extensive removal of bone at operation with its consequent unnecessary shortening, for the purpose of contacting the more active bone-growing tissues, this was done in accordance with the theory that the etiological factor in pseudoarthrosis might be traced to some local inability to grow bone in the ends of the fragments.

The introduction of foreign substances, such as metal plates, wires, nails, etc., has been also made in an attempt at correction, frequently in conjunction with operative procedures such as the foregoing. The disadvantages of using metal to hold ununited bone fragments in place cannot be emphasized too strongly, as an additional fixation agent to the bone graft is *absolutely contraindicated*. For some years it has been an established fact that metal, when inserted into healthy, well-nourished bone will cause absorption of the bone it comes in contact with, if it is a destroyer of healthy bone tissues, how much greater must be its destructive influence when it is brought into contact with the free bone graft before and during the period of the establishment of its blood supply! The metal plate is distinctly contraindicated as a supplemental fixation agent to the graft. When used in this way it exerts the destructive influence of a foreign body on local bone cells. It interferes with internal primary union and causes an exudate in the region of or about the graft, thus seriously interfering with the local circulation and consequently impairing the nourishment to the graft and the bone ends. Also, by its introduction the graft is robbed of that most valuable stimulus to normal metabolism and bone growth which is afforded by the graft bearing mechanical stress. The importance of this very influence upon detached blocks of bone cells or unimpaired skeletal bones cannot be too strongly emphasized. In extreme cases of infantile paralysis the diminution of mechanical stress will in part cause the bone cortex to become one-fourth its normal thickness, it will cause all the diameters of a skeletal bone, otherwise unimpaired, to become less than normal. The same phenomenon is true also in ununited fractures with loss of bone, etc. On the other hand, the presence of mechanical stress will cause an almost proportional increase in the diameters of a Sadow's bone, or it will cause a graft of any length of only one-third of an inch or less in diameter to grow back the full diameter of an adult femur.

The inadequacy of such methods as the foregoing in the treatment of pseudoarthrosis is indicated by their very number and variety. During the past twelve years, the author has closely studied many cases in which one or more of these forms of treatment had been carried out. As a result of his observations, it is his firm conviction that all such non-operative procedures,

and particularly those involving the introduction of metal, have no place in a consideration of the *proper* treatment of pseudoarthrosis. The bone-graft operation is the *only* method offering a solution of this problem, and the *inlay* type of technic is the most trustworthy one. These conclusions are based not only upon data resulting from extensive animal experimentations, but more particularly upon a series of more than two thousand bone-graft operations personally performed on the human subject.

In pseudoarthrosis, we have loss of osteogenetic activity at the ends of

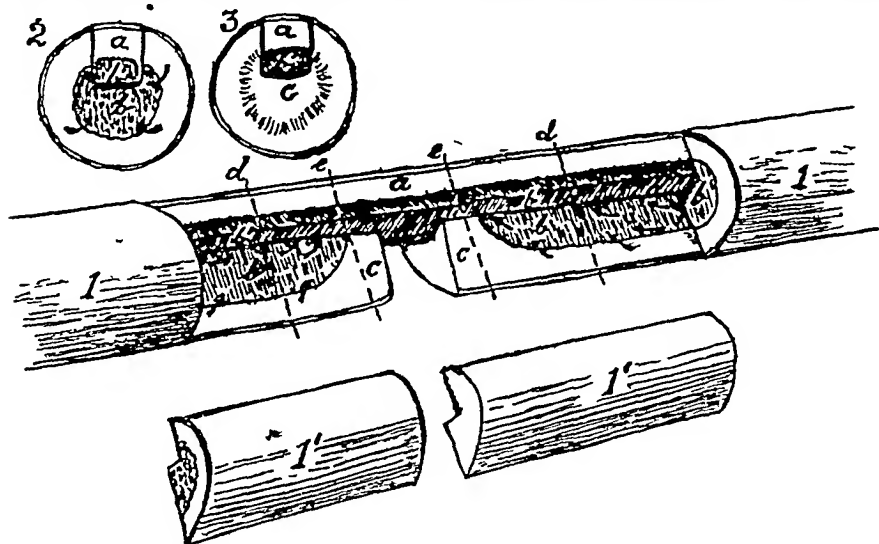


FIG 1—Diagrammatic drawing to illustrate the requisite apposition of bone layers of graft with corresponding parts of host-bone in the bone graft treatment of pseudoarthrosis in this case with loss of bone. These proper relationships of graft-layers with host-layers can be satisfactorily secured only when the graft is inserted by the *inlay technic*.

In this illustration *a* is the inlay graft inserted in the host fragments indicated by *r*. Portions of the host fragments indicated by *r'* have been schematically removed for the purpose of disclosing the interior structures and relationships.

It is necessary, as shown in this drawing, that the graft be of sufficient length to extend well beyond the eburnated area of the host fragment ends (indicated by *c*) so that it may come in generous contact with the healthy vascular host marrow indicated by *b'*.

healthy vascular host marrow illustrated by *d*. This relationship is further illustrated in a cross section made at *d*, which shows the inlay graft *a* in place with its marrow *b* in generous contact with the host-marrow *b'*. A second cross section *e* has been made at *e* through the oburnated ends of the host-fragments indicated at *c*. This demonstrates the inlay graft *a* with its marrow *b'* in place in the gutter in the oburnated ends of the host-bone which has been made sufficiently deep to receive the graft. The marrow as shown in *g* not only serves as an osteogenic force but on account of its continuity from one host-fragment to the other it forms an important vascular and osteogenic conducting bridge. The arrows in *r* and *z* indicate the direction of blood supply from the host-marrow *b* to graft marrow *b'*.

The cross sections 2 and 3 show also the cabinet-maker fit of the inlay graft α with the host. This not only affords mechanical fixation of parts but also favors the stimulation to bone growth from frictional irritation (emphasized by Roux) and an early establishment of blood supply for the graft.

the bone fragments, and a failure of the new bone if it occurs (in many cases callus to excess appears around the bone ends) to bridge across and unite the fragments. Frequently in these cases there is also definite loss of bone substance. The object of the inlay bone-graft treatment of this condition is to supply the osteogenetic deficiency in the bone-ends by transplanting in from elsewhere new and active bone-growing cells in such manner that the blood supply will be sufficiently early established and adequate to their continued life and proliferation, at the same time that the graft furnishes the necessary fixation of the fragments.

Many former methods failed to secure this desired result. The secret of

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the success of the inlay bone graft, following nature's laws of biology, physiology and metabolism, is based upon the transplantation of *healthy active bone-cells* to replace those which have lost their osteogenetic activity. As is clearly shown by Fig 1, the inlay bone graft affords a vascular bridge of marrow substance and periosteum as well as active bone-growing cells, extending from the healthy bone tissues of one fragment to those of the other.

The fundamental principles of bone growth and metabolism, upon which is based the technic of the inlay bone graft, must always be borne in mind. The importance of the observance of these laws can, perhaps, be best emphasized by a consideration of some of the conditions most necessary to the successful employment of the bone graft in the treatment of this extremely difficult surgical problem.

The graft should always if possible be *autogenous*, and either a sliding *inlay* graft from one of the fragments, or taken from the tibia or some other source.

It must be the *internal fixation agent* as well as the *active osteogenetic element*.

It must receive early and adequate supply of blood not only for its favorable growth but for its *very cellular existence*.

Since its blood supply must come principally from the marrow substance, which is the main normal source of blood supply in bone, the graft should contain marrow as one of its definite component parts.

In order that the fundamental laws pertaining to tissue transplantation be fulfilled, the graft must, in fact, consist of *all the four bone-layers*, namely, periosteum, compact bone (cortex), endosteum and marrow. The tissue-layers must be brought into apposition with the corresponding layers of the host-bone, in as nearly perfect apposition as possible.

The graft should be so placed that its marrow substance may serve both as a vascular and as an osteogenetic bridge extending from the marrow of one host-fragment to the marrow of the other. In other words, it must lie in generous, extensive contact with the un-traumatized marrow substance of the host-fragments on either side of the hiatus at the point of non-union. The graft must fit with a cabinet-maker exactness, thereby favoring the early establishment of blood supply, and allowing, to the maximum degree, the operation of Roux's law of frictional irritation (microscopic in amount).

If due regard is to be paid to the biological and to the mechanical principles involved in the use of the bone graft in the treatment of pseudoarthrosis, it is obvious that the *large inlay graft* is the only type which may be successfully employed to secure fixation of the fractured fragments, or to restore extensive bone loss. This type of graft, which by motor-saw technic may be easily cut and removed so as to contain all four bone-layers, is not only capable of serving as the *sole internal fixation agent* for the fractured fragments, but is a *potential grower of new bone*, depending upon its early establishment of sufficient blood supply from the host-tissues.

Despite the difficult requirements in the surgical treatment of pseudoarthrosis, the author realizes that other types of graft, such as the osteo-

periosteal, the pedicled and the intramedullary, have, from time to time, been advocated and used with a certain degree of success in these difficult conditions, a large proportion, however, of the cases, in which these methods have been successfully used were gunshot (military) origin, in which true pseudoarthrosis did not exist. The osteo-periosteal graft is wholly inadequate not only for purposes of fixation, but as a satisfactory osteogenetic factor in the proliferation of new bone in cases of pseudoarthrosis. Its only possible use should be as a supplement to the main inlay fixation graft. The author, however, *never* employs this graft for any purpose, believing that a bone

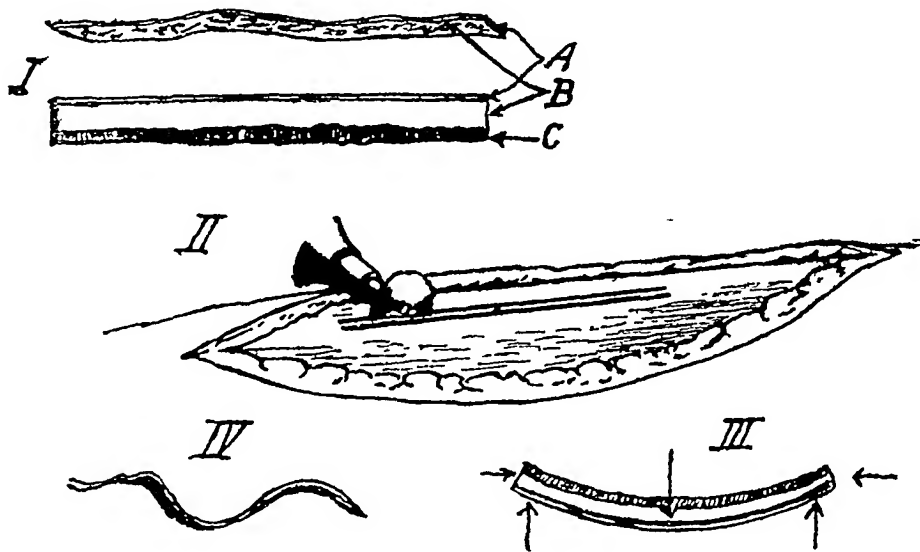


FIG 2 —In these diagrammatic drawings Figs I II III and IV illustrate the fundamental differences in structure and in mechanics between the osteo periosteal graft as usually removed by chisel or osteotome, and the author's silver graft removed by means of the motor saw, as shown in II.

In Fig I the upper drawing demonstrates the osteo periosteal graft with its ribbon of periosteum, A, to which are attached plaques of bone cortex B. As is evident from this diagram this graft does not possess the mechanical continuity of a rigid structure, moreover it entirely lacks endosteum and marrow.

In striking contrast to the osteo periosteal graft is shown the author's silver graft the lower figure in I. This graft is composed of *all four bone-layers* namely periosteum A compact bone B and endosteum and marrow C. It is a complete bone unit. Furthermore it is a rigid structure without solution of its continuity at any point and it is thus capable of bearing mechanical stress and is constantly under that powerful stimulus to bone growth. The arrows in Fig III indicate the direction of the mechanical forces which may be brought to bear upon this graft bending it in a microscopic or in a macroscopic degree. This illustrates the underlying etiological factor in the stimulus to bone growth afforded by mechanical stress. The impossibility of applying this principle to the osteo-periosteal graft is well demonstrated in Fig IV.

graft, even when used supplementally, should consist of *all four bone-layers* to be the ideal producer of new bone. For years, however, it has been the contention of the author that the *efficient bone-grower* was not one individual bone layer, nor another, but the *complete physiological bone-unit*, consisting of all four elemental layers, each fulfilling its particular and necessary rôle and correlating with the others in the process of metabolism and bone proliferation.

The osteo-periosteal graft, as usually obtained by means of chisel or osteotome, consists of a strip of periosteum to which are attached more or less isolated chips of hard bone.

Because of the source of this type of graft, it is inevitable that endosteum

and marrow substance should be lacking, and, therefore, it is not a *complete osteogenetic unit*, nor a mechanical factor since it has no rigid continuity. Such a graft is thus not only unreliable as a bone-growing entity, but, owing to its inability to resist mechanical stress, it is incapable of responding to this most potent stimulus to bone growth.

It has been unfortunate that the osteo-periosteal graft has been used so extensively in the attempted treatment of pseudoarthrosis, especially in the repair of fractures of the lower jaw, with extensive bone loss. In such cases this type of graft has been entirely inadequate to secure fixation of the jaw fragments, or to afford the proper moulding of the contours of the face. Moreover, its lack of sufficient osteogenetic elements, particularly the blood-carrying marrow, does not favor the ultimate establishment of blood supply. Owing to its unadvisable use, failures have resulted, and certain members of the profession have swung to the employment of an awkward and mechanically inadequate substitute, namely the *pedicle graft*, taken from one of the jaw fragments. The pedicle graft has been "a snare and a delusion" in the cases of both fascial and bone grafts, in that it rarely fulfils its one and only object, namely, the transmission of blood to the graft. Either by traumatization of the pedicle, or by its twisting, the blood-vessels do not remain patent, and the only reason for employing a difficult and many times a destructive technic is nullified. It is, moreover, apparent that in any appreciable loss of bone it is impossible to obtain a pedicle graft of sufficient length to provide requisite fixation or satisfactory cosmetic results. Another obvious disadvantage to its technic is that it involves in its removal extensive dissection of the muscles of the neck, just below the jaw. The only justifiable use of the pedicle graft is in selected cases of jaw fracture in which there is little or no loss of bone.

The contraindications to the independent use of the osteoperiosteal graft, or the pedicle graft, are especially emphasized in pseudoarthrosis of the inferior maxilla with extensive loss of bone. This branch of bone repair presents great difficulties of mechanical fitting and adjustment. Although electrically driven instruments in all branches of plastic bone work are necessary, in surgery of the lower jaw they are absolutely indispensable. Owing to the irregularity of contour of the jaw fragments, hardness of the bone, as well as lack of anvil stability, this work demands a precision and an accuracy of technic which can be obtained only by the employment of delicately adjusted motor-driven tools, such as the Albee circular saws, burrs, drills, end-mills and the like. The cosmetic result is of primary importance in these cases, depending in many instances entirely upon the construction of a *suitable graft-framework* over which to mould and restore the contours of the face. It is only by means of a *strong graft* moulded for this purpose and firmly *inlaid* into each jaw fragment that the restoration of the proper facial contours can be accomplished.

At a recent congress of the French Orthopædic Association, held at Paris, the author heard a French surgeon make the statement that he had never

in all his experience seen one successful result from the use of the osteoperiosteal graft in true pseudoarthrosis. Such a statement is hardly surprising, for a large percentage of successful results cannot be expected from the use of this graft when we consider the salient features in its technic.

1 Owing to its lack of rigid continuity the osteoperiosteal graft is incapable of furnishing fixation, even to the slightest degree.

2 By nature of its removal it cannot be a complete osteogenetic unit.

3 Since it does not possess rigid continuity, and is therefore incapable of bearing mechanical stress, its metabolism and bone growth are not influenced by that powerful stimulus of withstanding mechanical stress without fracturing.

In place of the osteoperiosteal graft, which the author formerly employed supplemental to the fixation graft, he now employs the so-called "sliver-graft." This is obtained by the motor-saw (see Fig. 2) in the same manner as the large inlay graft, namely, by cutting through the full thickness of the cortex into the marrow substance. In this case, the "sliver-graft" is obtained by single saw-cuts, it is about 1 mm. in width, and may be of any length, although usually of 6 cm. As shown in Fig. 2, this "sliver-graft" is composed of all four bone-layers, and, although of small dimensions, it is actually a *complete bone-unit*. It is so placed that it spans the hiatus between the host-fragments, with its two ends engaging upon the fragment ends at a point where the periosteum has been turned back. It is so thin that it bends and takes the contour of the bones with which it is in contact, as soon as it becomes united to the bone, on either side of the non-union, it is subject to end-bearing or lateral stress at the slightest movement of one bony fragment upon the other, or from contraction of the muscles lying alongside. Since it possesses mechanical continuity, in marked contrast to the osteoperiosteal graft, it is constantly under the influence of the stimulus exerted by withstanding mechanical stress without breaking. The greatest value of this graft is in its use as a supplement to the main fixation graft, for the purpose of furnishing additional foci of bone growth.

In concluding a recent report of a large and varied series of cases of pseudoarthrosis following gunshot injuries, treated by bone graft in his military work, the author urged the scrupulous observance of certain essential points in treatment and technic to which he attributes, in large measure, his successful results in this difficult work. A brief résumé of these requirements seems not inappropriate as a summary of this discussion.

1 *Time to Operate*—A careful study of the wound should be made, before it has healed if possible. The type of infecting organism (*streptococcus hemolyticus*, gas bacillus, etc.), the nature of the "clean-up" operation, and the manner of healing of the wound should be noted. These observations have a direct bearing on determining the time when it will be safe to operate.

In a few cases it may be permissible to operate after the wound has been completely healed for a period of two months, while in others, on account of possible latent infection where the previous infection has been streptococcus

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hemolyticus, etc., it may be advisable to delay the final plastic work for at least six months. In some of the latter unfavorable cases a two-step operative method may be followed, consisting of a preliminary excision of scar tissue with its replacement by a healthy skin-flap, muscle, fat, etc., followed after a period of from ten days to two weeks by the bone plastic procedure.

2 *Immediate Pre-operative Observation of Patient*—In order to ascertain whether or not latent infection capable of recrudescence exists, splints should be removed, and rough manipulation and deep massage should be given for a period of from one to two weeks before operation. During this time observation of the temperature should be made, and likewise careful examination of the parts for local tenderness or any evidence of recrudescence of infection. The field of operation should be given a forty-eight hour preparation by the tincture of iodine technic.

3 *Plan of Operation and Choice of Incision*—By radiographic and physical examinations, the proposed plan of operation, particularly with reference to location of graft, should be made before actual incision. If it is possible, the skin incision should not be located directly over the intended bed of the graft. The operation must be so planned that the graft may be covered without undue tension of skin, and, if possible, placed so that it may come in contact with healthy tissue instead of scar. In a number of cases in which this was accomplished, the graft healed by primary union, whereas the scar, even at a considerable distance from the graft, broke down entirely. In cases in which there is extensive loss of bone, the scar tissue should be pushed to one side, in order that the graft may come in contact with healthy tissue. Drainage wicks, of any kind, must never be inserted at the time of the operation.

4 *Length of Operation*—The author believes that the shortest possible operating time that is consistent with good work, and with minimum amount of trauma, is requisite to successful results in this work.

5 *Use of Motor-Driven Tools*—These are essential for the following reasons:

(a) On account of the necessity for rapid work in order to avoid drying and traumatization of both the graft-tissues and the host-tissues.

(b) To secure a cabinet-maker fit of parts, thereby providing for early and adequate blood supply to the graft, for mechanical fixation and for the operation of Roux's law of frictional irritation which is a great stimulus to bone growth.

(c) On account of taking advantage of the law of anoci-association.

The motor outfit with its tools to secure automatic fits seems indispensable in this work. The motor-saw when properly used does not heat nor glaze the bone. This has been shown repeatedly by the author in experimentations made formerly and repeated during the past few months.

6 *Adequate Length of Graft*—The bone graft should always, if possible,

be of the inlay type, and of sufficient length to extend into each fragment for a distance of at least 5 cm, and always well beyond the eburnated area at the ends of the fragments. The gutter should extend well into the healthy marrow of the host-bone, with which the graft-marrow should be in generous contact. It is important that the marrow in the fragment ends should not be crushed or unduly traumatized, and that the gutter in it should be of proper depth to just receive the graft, so that there will be a close approximation of the marrow of graft to the marrow of the host-fragments, thus favoring the early and profuse anastomosis of blood-vessels between these very vascular tissues. It is also important that a marrow-bridge be formed from the marrow substance of one host-fragment to that of the other for the transmission of blood-vessels, bone-cells, etc., across the point of non-union.

7 *Type of Graft*—The graft should be autogenous, consisting of *all four bone-layers*, namely, periosteum, complete thickness of cortex, endosteum and marrow. It should be so inlaid that the fit is perfect, with an exact apposition of layers of the graft to the corresponding layers of the host-bone. This exact contacting fit favors the mechanical fixation of the fractured bone and the graft, it also permits the frictional stimulus to bone growth, emphasized by Roux, and in every way favors the earliest bony union of graft to host-fragments.

8 *Supplemental Grafts for Additional Foci of Bone Growth*—Small "sliver-grafts" about 1 mm in thickness placed alongside of the main fixation graft furnish additional foci of bone growth. They are most efficacious when used in this manner.

9 *The Graft as the Main Fixation Agent*—Fixation should be secured always by the graft itself, and never by metal plates or other foreign material, for the metabolism of the graft and bone growth are directly influenced by the stimulation from the stress carried by the graft.

10 *Suture Material*—A minimum amount of absorbable suture material should hold the graft in place. For this purpose kangaroo tendon is the most ideal material, since it is tolerant to the tissues, readily absorbable, very strong and reliable. For the skin and the underlying soft parts fine absorbable suture material should be used.

11 *Post-Operative Fixation*—Firm immobilization of the limb by a plaster-of-Paris cast should be maintained for a period of at least ten weeks following operation, and as long thereafter as radiograph examination shows it to be required. Great emphasis should be placed upon the importance of very efficient immediate post-operative fixation, and this can be accomplished only by the most expert management of a suitable fracture orthopædic table (such as the Albee fracture table) which will allow control of both the upper and lower extremity and skilful plaster-of-Paris technic.

The author is convinced that failures in cases of pseudoarthrosis operated by others, where the bone graft was used, were due many times more to inadequate post-operative fixation than to poor operative technic. This statement is especially true in cases with or without loss of bone substance in the upper

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two-thirds of the humerus, where it is absolutely necessary to immobilize both the elbow and the shoulder joints by a plaster-of-Paris shoulder spica, and it was for this type of cases more than for any other that the author was induced to devise his fracture orthopædic table

Adequate fixation of the graft, following its insertion, is equally essential in the same work in the vegetable kingdom

Grafting wax is more necessary for this purpose than it is in protecting the cut surfaces from vegetable parasites. It is for this reason that when the wax does not remain hard and becomes unduly soft under the sun's rays, successful results are interfered with

Attention is again drawn to the importance of using absorbable skin suture material, in order that the plaster dressing need not be disturbed until time for the splint to be removed

RESULTS OF TREATMENT OF 115 CASES OF FRACTURE OF THE SHAFT OF THE FEMUR AT THE UNIVERSITY OF PENNSYLVANIA HOSPITAL

BY ELDRIDGE LYON ELIASON, M D
OF PHILADELPHIA, PA

THE statistical facts in this article are based on a series of the last 115 fractures of the femoral shaft, occurring in the various surgical services at the University of Pennsylvania Hospital, Philadelphia. There has been no attempt to compare any one man's work with another, but to find the method of treatment that gave the best result. In the last four years our ideas about the treatment of fractures of the shaft of long bones, especially of the femur, have undergone some striking changes. Some years ago our treatment for all fractures of the shaft, not including the neck, was either a double inclined plane, a fracture box, or a plaster casing from the toes to the costal margin, with the limb usually in the mid-position, *i e* in the long axis of the body with no flexion at hip or knee. In some instances, traction and lateral support in the flat position constituted the dressing.

The results did not appear sufficiently satisfactory, and so the open reduction and internal fixation was tried in increasing numbers of cases. Again, most operators applied plaster casing with the limb in practically the straight position, *i e*, laying flat on the bed. Still the results did not satisfy. Later two or three of the surgeons began to practice the principle of flexion of the thigh and leg and traction in all cases, including those with internal fixation by wire, bands or plates. To render the nursing of these patients easier they were fastened to a modified Bradford frame¹. Use was made of the Hodgen splint with traction in certain selected cases and more recently the Thomas splint was also used. All of the methods have been employed in the present series, and in some cases two or more of the methods have been used in an attempt to accomplish position.

The series is composed of 115 cases of fractures of the shaft of the femur. No cases of fracture of the neck, non-union of the shaft, or shaft fractures associated with other serious trauma which resulted in early death are included.

Age—The youngest patient was eleven months old. The oldest treated primarily for the fracture was seventy-six. The decades with the greatest number were the first two. There were twenty-nine cases under ten years of age and twenty-seven cases of the series were in patients within the ten to twenty year age group. That is, 48.7 per cent of the cases were patients under twenty-one years of age. The next largest group of 17 per cent occurred in the third decade between twenty and thirty, and the smallest group of 2.6 per cent occurred in patients between forty and fifty years of age. The other periods are of no interest.

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Character of Injury—This was not obtained in all of the series. Direct violence was the causative factor in 73 per cent of the cases and indirect violence the cause of 27 per cent. Of those due to direct violence an automobile was the cause of 42 per cent.

Type of Fracture—The fracture line was described as transverse in 56 per cent of the cases, oblique in 16 per cent, comminuted in 20 per cent, compound comminuted in 9 per cent, and unstated in 9 per cent.

Level of the Fracture—For convenience of classification the fractures have been grouped into those of the upper third, the middle third and the lower third of the shaft. The lower third includes supracondylar fractures but not condylar fractures where there is no lesion of the shaft proper. In the series, 20.1 per cent of the fractures occurred in the upper third, only two cases of which had comminution. The middle third of the shaft claims 56.4 per cent of the series with five comminution cases included. The lower third accounts for 24.5 per cent. An interesting feature of this group is that comminution occurred in 40 per cent of them, as compared to only 8 per cent of comminution cases in each of the other groups. Included among the fractures in the lower third are but two cases of epiphysial separation, one compound with torn popliteal vessels which resulted in loss of the leg. The other gave a happy result under operative reduction.

Deformity—In all the cases with the exception of two, there was shortening ranging from 1 cm. to 6.5 cm. The upper fragment invariably was flexed and lay anterior while the lower fragment presented posteriorly. The upper fragment in the upper and middle third fractures was abducted. Three of the cases had fractures of both femora.

Treatment—Throughout the entire series it has been the policy of the various surgeons in charge of the cases to be conservative and accomplish reduction if possible by the closed method.

With this in view in every case, after the diagnosis, some attempt at reduction was made by manipulation and traction, and the limb dressed either with sand bags, a posterior splint, or an inclined plane, each with a temporary Buck's extension and weights ranging from 6 to 40 pounds, depending upon the musculature of the patient. An X-ray was then taken and treatment directed accordingly. In only seven cases was any anæsthetic other than morphia given for reduction. This was satisfactorily accomplished in but one of the entire series of eighty-eight, later proven by the X-ray. This one, with a cast applied in the flat position, was found again out of position when X-rayed two days later.

Thus we are faced with the astonishing fact that the results of the primary treatments were unsatisfactory in 100 per cent of the cases. It is fair to state, however, that in the great proportion of the cases but little, and that usually by the resident interns, or no attempt was made at reduction but merely a fixation and traction applied while waiting for the X-ray. If the X-ray revealed that the site and type of fracture so demanded, the limb was

dressed with traction and in splint, plaster or box in the flexed position, *i e*, thigh flexed on abdomen and leg on the thigh

Character of Dressing—For infants and young children the type of dressing most frequently used was the Buck's traction, with either one or both legs directed toward the ceiling. The writer has obtained the best results when both limbs were suspended. Enough weight was applied to just lift the buttocks so that they would swing easily, just touching the mattress. Rotation of the broken limb was prevented by parallel riders attached to the foot piece and projecting to straddle the rope on the uninjured side. In only one case, the oldest in the series so treated, a child of eight years, was a Steinmann nail traction necessitated.

The youngest case so treated was eleven months of age. There were twenty-four of these cases, up to age eight, of which fourteen were treated by this perpendicular traction, twelve of the fourteen, 84 $\frac{1}{2}$ per cent were reported on as having good results, three were operated and seven were put in plaster cast, and all were discharged as having no deformity. Of the two remaining one had a cm shortening and the other was reported merely as "overlapping." The three operated cases had good results. The seven cases treated with plaster casts showed no shortening in four (57 per cent), and with ultimate good results. We, therefore, may say that in this group our best treatment is clearly pointed out, namely, the perpendicular traction (Bryant). The results for this entire group of twenty-four cases can be considered good.

The remainder of the series, eighty-eight in number, really constituted the problem. An attempt was made in two or three of the cases of ten or eleven years of age, to dress with the perpendicular traction, but without success. The adhesive would not carry the weight of the limb in the perpendicular position.

In eighty of the series of eighty-eight over ten years of age, in which the primary type of dressing was mentioned, the adhesive extension (Buck's), or better termed traction, with weights was used. Of the remaining eight cases, some were operated at once because of the nature of the injury, and others were etherized and placed at once in a plaster casing in the flat position, *i e*, with the limb lying straight out and flat on the bed.

Following the eighty-eight fractures through, eight were later encased in plaster, including the pelvis and foot, of these six had shortening, ranging from one-half inch to $2\frac{1}{2}$ inches, one fibrous union, and one died, so we may state that the treatment gave satisfaction in none of the cases. In twenty of the cases failure caused a change of dressing to be made. The thigh and knee were flexed to about 45 to 60 per cent and supported with a Hodgen splint, an angled Thomas splint or a double inclined plane fracture box and traction in the line of the femur's long axis. This is the position of greatest ease and relaxation of the muscles that exert action on the femoral shaft. In every case of the series the upper fragment was flexed and when the lesion was in the upper two-thirds, slightly abducted, while the lower fragment was invariably rotated posterior. This was true even in the two cases

of epiphysial separation, despite the fact that the lower fragment as a whole was displaced anteriorly in these two cases alone. In those cases in which the reduction was not maintained by reason of loosened screws or broken plates there was always the return to the old deformity, in those cases dressed flat without regard to muscle action. When, however, by flexion and abduction the muscles were placed in a state of "equilibration" and traction added this deformity did not return, but shortening persisted in eight cases, due to insufficient traction. Thus, this, the second attempted treatment, gave good results with no deformity in 25 per cent. in this group of twelve cases.

This was the final treatment in twelve of the twenty cases of which three recovered with no shortening, two of which were direct bone pin extension cases, one resulted in amputation because of vessel injury at the time of the accident, and eight had a resultant shortening ranging from one-half to three-quarters inches and one with $1\frac{1}{2}$ -inch shortening was too sick from a head injury for any radical treatment of the fracture. This last case had both femurs broken and a resulting $1\frac{1}{2}$ -inch shortening in both limbs—hence no limp.

In eight of these twenty cases dressed in the flexed position satisfactory reduction was not obtained and open operation was done. In six cases perfect results were obtained, one a case of compound comminuted fracture involving the knee-joint died of septicæmia, and one case in which no traction was used had a resulting $\frac{3}{4}$ -inch shortening and angulation.

In forty-six cases, after the first reduction and fixation in the "flat on the bed" position did not produce results, and in the eight fractures, unsuccessfully dressed in the flexed position, operation was decided upon. The Sherman plates with four or six screws were used in forty-seven cases, wire in three, Parham-Martin bands in two, and no internal fixation in two. After operation twelve were dressed in the flexed position, 2 e, leg and thigh flexed to 45 per cent. and thirty-four were dressed in the flat position. Plaster casings were used in all fifty-four cases and postoperative traction was applied in ten, of which six were bone pin and three adhesive traction and one was by traction screws incorporated in segmented plaster casings. The majority of the open operations were performed within the first eight days. Comparatively few were done within the first twenty-four hours. It was universally noticed that the earlier the operation the easier the reduction.

The results were grouped for study and analysis into those of early occurrence, such as infection, permanency of the internal bone fixation and union, and secondly the ultimate results such as the amount of lasting disability, etc.

Infection—Infection occurred in six, 15 per cent., of the operative wounds of the total of fifty-four operated cases out of the entire 115. This occurred in the earlier cases of the series, and necessitated the removal of the plate in three of the cases. The type of the infection in these cases in which a culture was taken, was found to be a staphylococcus. Fourteen of the wounds were drained with a rubber tube for forty-eight hours. In none of these was there

any infection It was, however, noted that the majority of the operative cases ran a more prolonged and a higher temperature than should be expected

No one of the retarded union or non-union cases occurred in these fourteen drained cases It is possible that draining the hæmatoma, which must to a more or less extent occur in such an operative wound, allows the tissues to fall together and the stripped-up periosteum to cover the bone more closely, consequently encouraging reparation Of these same fourteen cases, however, twelve were dressed in the flexed or muscle equilibrium position with post-operative traction

Bone traction by the Steinmann pin was used in only six cases in all These all had an infection develop peculiarly at the entrance site of the pin In only one case did the infection reach the bone, in which case an acute epiphysitis occurred necessitating the removal of the pin and the establishing of drainage some three weeks later This patient, a child of eight, has been followed up and an X-ray taken recently, four years since the operation, shows a healthy bone and a perfect result at the fracture site Tongs were used in two cases, neither of which resulted in infection

Paralysis —In three cases, a peroneal palsy developed with its associated toe drop This in one case was due to a tight cast just below the head of the fibula and in two cases to the cinch used around the upper part of the leg in obtaining traction at the time of operation All three cases recovered within seven weeks

Duration of Plate, Wire and Band Stability —Plates were used in forty-seven of the cases The screws became loose, resulting in angulation in ten clean cases and in three infected cases The plate broke in three cases allowing angulation in two and overlapping in the other case It became necessary to remove the plates in ten cases, seven clean and three infected, and the bands in one case

It is interesting to note here that in only two of the sixteen cases in which the plates failed was there traction applied after plating In one of these two the limb was put up in the flat position and in the other there was infection In the three cases in which wire was used one resulted in 1-inch shortening and the other two developed angulation In none of the wired cases was traction used after operation In the two cases in which bands were used, one resulted in subsequent angulation and shortening necessitating a second operation, and the other cannot be traced

From the above we must notice that in the twenty-one cases, 44.7 per cent, in which the internal fixation failed of its purpose, only two occurred in the presence of postoperative traction, and these two were explained the one by infection and the other by faulty equilibration of the muscles Only one of the twenty-one cases occurred with the limb in the flexed position and that was in the absence of traction

Union —It may be well to state here that the state of union was determined by X-ray and physical examination at the time of discharge from the

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hospital In the entire series of 115 cases there were fifteen ununited, as follows one each after 49, 60, 67, 84, 87, 180, 240, 55, 93, 143, 126, 70 and 74 days after operation The remaining two cases have no record of the number of days In answer to inquiry letters three of these cases have subsequently obtained union, the others could not be traced

When examined in groups we find fourteen of the poor union cases were operative and one was non-operative, of the operative cases three were infected, five were comminuted and one was a case in which no internal fixation was used The non-operative case was a man of seventy years of age

Here again the flexed position has a clean slate with no delays or non-union to its credit All the non-union cases had been dressed in plaster and flat on the bed None of the operative non-union ones were drained Only one had postoperative traction applied and in none did the fixation remain firm Relative to the site of the fracture, nine were in the middle third, four in the lower third, and two in the upper third of the shaft Age of the patient had no apparent bearing on the absence of union

Six of these cases were sent home in their casing at periods ranging from eighteen to forty-eight days and told to report on a certain date, at which time angulation and non-union was found, or angulation sufficient to be reported as vicious union

Deformity—The presence of deformity was determined by the amount of shortening or the demonstration of angulation by X-ray at the time of leaving the hospital It is only fair to state that a great number of the cases with angulation, ten of a total of thirty-six, pass clinically as good results though the X-ray shows a deviation from the straight axis, yet they still remain as examples of failure of fixation

Of the eighty-eight cases there were thirty-six with no deformity, either shortening or angulation by X-ray There were thirty-six with deformity The remaining sixteen were made up of two cases of amputation, two deaths and twelve undetermined

Of the thirty-six cases with deformity, twenty were operative cases, ten of which, having only X-ray deformity of slight angulation and no shortening or other clinical evidence of deformity, cannot be so considered, but three showed shortening and seven showed deformity angulation The angulation cases with one exception had been dressed in the flat position

For all practical purposes, viewed clinically, functionally and æsthetically, the incidence of deformity in the fifty-four operative cases was ten, or 18.4 per cent The ratio of deformity in non-operative cases was sixteen in the thirty-four, or 44 per cent Of these sixteen cases, thirteen were a loss of length and three were angulation, pronounced enough to be noticeable

This shows that operation resulted in shortening in three cases and bad angulation in seven, in all 18.4 per cent, whereas non-operative procedures resulted in thirteen cases of shortening and three of angulation, 44 per cent deformity All angulation cases necessarily show some shortening

In the series of eighty-eight, 18.8 per cent of the cases showed shortening and 11.3 per cent showed angulation, a total of 30.1 per cent

We therefore find that by the operative treatment, we obtained 81.6 per cent good results, and by the non-operative methods we obtained in the entire series 73.9 per cent good results, but only 56 per cent good results in the series limited to ten years and over

Carrying the analysis of the operative good results further we find that the flexion and traction postoperative treatment was given in ten cases with plaster casings for external fixation. The results were nine cases with no angulation or shortening and one case with $\frac{1}{4}$ -inch shortening, i. e., 90 per cent good results, practically 100 per cent, as such a small shortening is negligible

Of the thirty operated cases dressed in the flat on the bed position and in plaster with no traction, twenty resulted in deformity, usually angulation, i. e., 33.3 per cent good results

The remaining fourteen operative cases were divided between Hodgen splint two, Thomas splint two, posterior splint and plaster two, and others not described definitely enough to report

Days in Hospital—Of the seventy-five adult cases the hospital term has been taken in forty-eight, twenty-eight operative and twenty non-operative cases. The average stay in days for the operative cases was eighty-three days, and for the unoperated cases sixty-three days

Mortality—There were three deaths in the 115 cases. One was a result of embolus, one a compound comminuted case died of septicæmia, and another compound with lacerations died from gas gangrene

Morbidity or Permanent Disability—The number of reports obtainable is not very satisfactory. Only forty cases show reports after leaving the hospital

In addition to the twelve cases of delayed or non-union, nineteen cases have no complaint or disability, two suffered amputation, two have a stiff knee, one wears a high shoe, one wears a brace, one uses crutches, one is convalescing from a second operation for vicious angulation, and one case has a relaxed knee joint resulting in a "back knee". This patient was plated, put in plaster casing in the flat position, and a fenestra cut over the wound for removal of drainage tube. As did occur in three cases of this series and in five other cases brought to the writer's attention from other sources under similar treatment, i. e., with lack of traction and muscle equilibration and the presence of a fenestra, the screws pulled and angulation occurred projecting into the fenestra

The effort to correct this by traction on the leg resulted in the relaxed knee joint. This is a point to be borne in mind in choosing between adhesive or direct bone traction, exerted on the broken bone itself rather than with a joint intervening

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SUMMARY

1 In patients under eight years of age the Bryant or perpendicular treatment gave the best figures, 85 per cent excellent, or 100 per cent good results In this group all results were reported as good

2 In the eighty-eight cases ten years of age or older the primary reduction and dressing was not satisfactory in a single case

3 A small group of eight cases later set in plaster under traction, all showed shortening or non-union

4 The next group of twenty cases dressed in the flexed position with weight traction gave 25 per cent good results with no deformity

5 In operative cases infection occurred in none of the drained wounds Every case however showed slight infection around the Steinmann nail

6 Internal fixation failed to hold the fracture in twenty-one of fifty-four cases Causes of this failure were in the greater number of cases due to the position in which the limb was splinted, twenty being dressed in the flat position, and to a much less extent to infection, only three cases

7 Non-union, or better, union delayed longer than seven weeks, was most often due to faulty fixation of the fracture, and occurred in 22.2 per cent of the operative, 0.86 per cent. of the non-operative and 10.4 per cent of the entire series It is hardly fair to include these figures as other than undetermined, as they have not been heard from finally

8 Operation gave 81.6 per cent good results, non-operative methods gave 73.9 per cent. good results in the entire series of 115 It must be remembered, however, that this last figure is helped enormously by including the twenty-four youngsters with 100 per cent. good results

9 Of the operative procedures, the use of plates and screws with wound drainage and the limb dressed in plaster, in flexed position, with postoperative traction maintained, gave 90 per cent perfect results, plus 10 per cent good All other operative methods gave but 33.3 per cent perfect results plus 33.3 per cent good results

Plaster casings are not a good permanent dressing unless traction is used and the case kept under close observation until union is firm and especial care being taken as shrinkage of the limb occurs, a new cast be applied This last is very important, for if there is too much room in the cast at the fracture site, each time the patients raise themselves in bed the psoas muscle acting against the fracture will loosen the internal fixation If these precautions are taken, however, plaster makes an excellent dressing if cut out so as to permit knee and ankle motion

10 From the above facts we see that the best treatment was operation with plate fixation and drainage and the same amount of attention given to external fixation, flexed position and traction as would be given were the case treated by the closed or non-operative method

¹ Eliason Method of External Fixation for Fractured Femur Surg, Gyn and Obst, Oct, 1918

FRACTURE OF THE METATARSAL BONES*

WITH A REPORT OF FOUR CASES

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FOUR cases of fracture of the metatarsal bones have come under my care at the Episcopal Hospital within the past few months. In three of these cases the results of treatment have been very satisfactory. The fourth has been too recent to determine the final outcome, although so far he has progressed most satisfactorily and I believe he will also get a useful foot.

Apparently very little attention has been given to fractures of the metatarsal bones, as I have been able to find only a few articles in the literature, and the text-books dispose of the subject in very few words.

All of the text-books which I have consulted written prior to Robert Jones'¹ articles in 1902, when he described a fracture occurring in his own fifth metatarsal as the result of indirect force, describe the fracture as usually being due to a direct or crushing force. Since Jones' article, the more recent text-books still adhere to the direct or crushing force as being the most likely causative factor, but make mention of Jones' article or say that it is possible for the metatarsal bones, especially the fifth, to be broken by indirect force.

Certainly fractures of the metatarsal bones have been considered quite rare, as Agnew² states that during a period of forty-four years twenty-six cases were admitted to the Pennsylvania Hospital, and that only three or four cases were treated at the Hôtel Dieu, Paris, during a period of eleven years. From 1905 to 1920 one hundred and four cases of metatarsal fractures have been admitted to the Episcopal Hospital, fifteen of these were compound.

Wharton³ reported two cases of fracture of the metatarsal bones as the result of a twist of the foot, the so-called soldier's fracture, and Tabold has reported over 700 cases observed in soldiers, almost all caused by indirect violence as in marching, jumping, etc. In Tabold's⁴ series, the second metatarsal was most frequently broken, then the third.

My cases were all due to direct foot injuries, but it was hard from the histories, except in Case I, to really understand the mechanism or to properly follow the line of force producing them.

In one case (Case I) transmitted or indirect force certainly played a part in breaking some of the bones.

The symptoms in all of the cases were quite marked and consisted of inability to bear the weight on the foot, swelling which came on very rapidly and was quite marked, ecchymosis, deformity, crepitus and mobility in some and marked localized tenderness in all.

In dealing with multiple fractures such as occurred in each of these, it was

* Read before the Philadelphia Academy of Surgery, April 4, 1921.

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impossible clinically to always tell the number of bones broken, the exact location of the fractures or the amount of displacement of the fragments

In Case III, where there was not so much deformity or swelling, we were able to make a probable diagnosis of a fracture by the exquisite localized tenderness to pressure although no crepitus or mobility was obtained

The first case on whom I operated, I did so with much hesitancy and fear. My war experience had taught me that there was nothing to be feared more than a compound fracture of the tarsal or metatarsal bones, and I feared if I operated and the wound became infected the case might terminate most disastrously. My experience, however, with these cases has shown that with good hospital facilities infection is not apt to occur, or is it after all that the foot not only was made to stand on but will stand a lot besides?

A brief history of the cases is as follows

CASE I—A C, white, male, aged twenty-six years, fireman, admitted May 10, 1920, discharged June 1, 1920. Diagnosis: Fracture of the shafts of the second, third, and fourth metatarsal bones, dislocation of the third, fourth and fifth metatarso-phalangeal articulations. On May 10, 1920, while sliding at great speed down a brass pole in the station house, the outer side of his right foot struck the floor with great force, causing his foot to turn under him. On admission to the hospital the right foot showed swelling and discoloration, more marked on the outer dorsal surface, crepitus and mobility and great tenderness over the second, third and fourth metatarsal bones and evident dislocation of the fifth metatarso-phalangeal articulation. *X-ray Report* "shows fracture of the shafts of the second, third and fourth metatarsal bones." "There is angulation of the fragments of the second and the heads of the third and fourth are dislocated completely outwards." "There is a complete dislocation of the proximal phalanges of the fourth and fifth toes." "The proximal fragment of the third metatarsal projects sharply towards the dorsum of the foot."

On May 11, 1920, under ether anaesthesia, an attempt was made to reduce the fractures and dislocations without success. On May 17, 1920, the patient was operated upon under ether anaesthesia. Elliptical incision with convexity towards the toes was made on the dorsum of the foot over the metatarsal bones. The heads of the second, third, fourth and fifth metatarsal bones at the phalangeal articulation exposed and the fifth reduced, being dislocated. The fractures of the distal extremity of the second, third and fourth metatarsals then reduced and held in position with chromic catgut sutures. Wound closed without drainage.

The patient made an uneventful recovery except for a small area of slough of the skin flap.

CASE II—J M, white, male, aged twenty-eight years, fireman. Admitted June 7, 1920, with a compound fracture of the shafts of the second, third, fourth and fifth metatarsal bones, right. Fracture dislocation of the bases of the first, second and third metatarsals, right. On June 7, 1920, while responding to a fire call the fire en-

gine on which the patient was riding was struck by a locomotive, and in the crash which followed his foot was crushed against the railroad track

On admission to the hospital his right foot and ankle were greatly swollen, with marked deformity, crepitus and mobility of all the metatarsal bones. The entire foot was exquisitely tender. The dorsal surface of the foot was markedly contused and there was a lacerated wound on the plantar surface. *X-ray Report* "Fracture of all right metatarsal bones." "The fragments of the second, third, fourth and fifth are shoved outwards and are fractured near the distal extremities." The first, second and third are fractured near their proximal ends and the first is dislocated inward on the cuneiform bone.

On June 17, 1920, under ether anæsthesia an unsuccessful attempt was made to reduce the fractures and dislocations. On June 24, 1920, patient operated upon under ether anæsthesia. Four longitudinal incisions made on the dorsum of the foot over the metatarsal bones. Dislocations and fractures of all metatarsal bones. Fractures and dislocations reduced and bones held in position by fine silver wire. Wounds closed without drainage. Recovery uneventful and patient discharged on July 17, 1920.

CASE III—F S, white, male, aged thirty-three years, knitter. Admitted November 1, 1920, with compound fracture-dislocation of metatarso-phalangeal articulation of great toe. Fracture shafts of second and third metatarsal bones.

On November 1, 1920, patient fell down an elevator shaft a distance of about twenty feet, landing on his left foot. On admission to the hospital his left foot showed a lacerated wound on the inner side at the base of the great toe. The first phalanx of the great toe is dislocated outwards. There was marked tenderness over the heads of the second and third metatarsal bones. *X-ray Report* "Fracture of the second and third metatarsal bones near the distal extremity, in fair position." "The distal fragments project somewhat towards the outer side of the foot." "Fracture-dislocation of the proximal phalanx of the great toe."

On November 1, 1920, under nitrous oxide anæsthesia, patient was operated upon. Incision about three inches in length made over the inner surface of the left foot at the base of the great toe. Dislocation of great toe reduced and capsule sutured with chromic gut. Wound closed without drainage. Patient discharged from the hospital on November 8, 1920, wound healed.

CASE IV—G B, male, white, aged fifty-eight years, machinist. Admitted January 29, 1921, with compound comminuted fracture of the shafts of the second, third, fourth and fifth metatarsal bones, right, dislocation of little toe, right.

On January 26, 1921, while on a ladder, it slipped from under him and he fell a distance of twenty feet. In falling, his right foot slipped through one of the rungs of the ladder so that in landing the ladder fell on his foot and he in turn on the ladder.

On admission the right foot was greatly swollen and ecchymosed



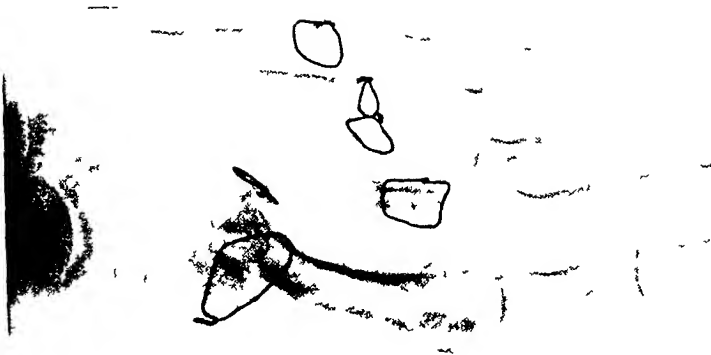
CASE I



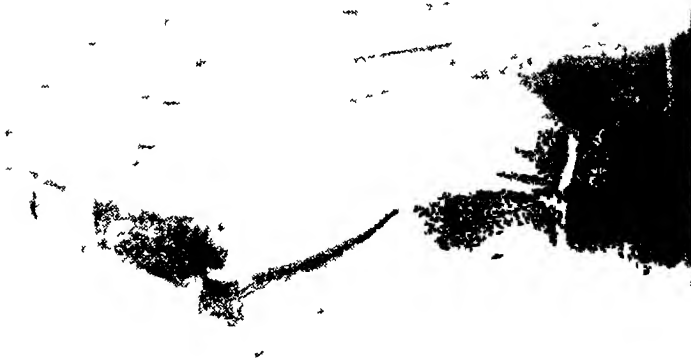
CASE I End Result



CASE II



CASE II End result



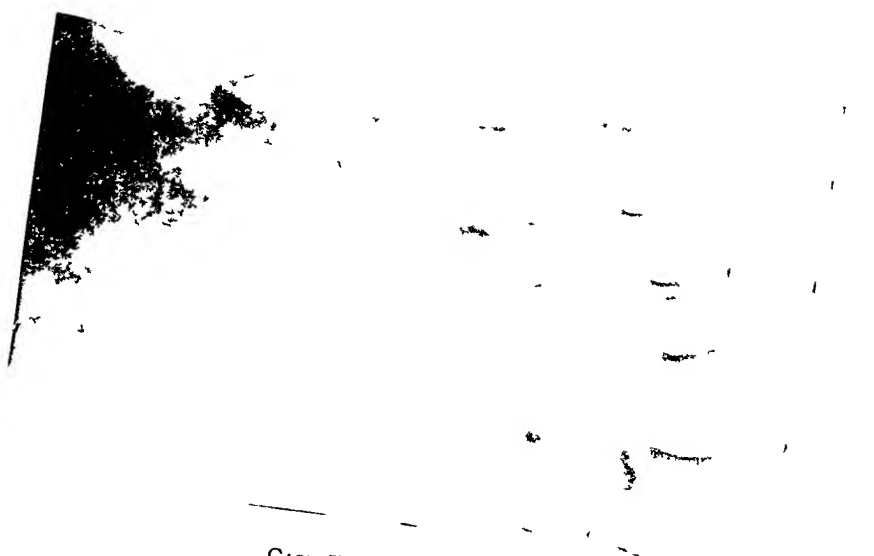
CASE III



CASE III End result



CASE IV



CASE IV End result

FRACTURE OF THE METATARSAL BONES

There was a puncture wound on the plantar surface of the foot opposite the second metatarso-phalangeal articulation. Marked localized tenderness, crepitus and mobility obtain over the distal extremities of the second, third and fourth metatarsal bones. *X-ray Report* "shows a fracture of the second, third, fourth and fifth metatarsal bones, distal extremities." "There is apparently a fracture of the cuboid." "There is also a partial dislocation of the first and fifth metatarso-phalangeal joints." "The displacement of the fourth metatarsal is quite marked."

The patient was operated upon under ether anaesthesia on February 3, 1921. Three incisions about three inches long made over the second, third and fourth metatarsal bones on the dorsal surface of the foot. It was found that the second, third and fourth metatarsal bones were badly comminuted and that the proximal fragments were markedly displaced towards the plantar surface of the foot. The fragments were reduced and an attempt was made to hold them in position by chromic gut sutures, but on account of the smallness and extensive comminution of the distal fragments this was found to be impossible. The head of the fourth metatarsal was so badly comminuted that it was removed. The wound was closed without drainage. Wound healed by first intention and patient discharged on February 22, 1921.

The⁵ tarsal and metatarsal bones are so arranged that they are somewhat dome-shaped, giving an antero-posterior and lateral arching to the foot. The antero-posterior arch has been divided into an inner and outer arch, the former consisting of the os calcis, astragalus, scaphoid, three cuneiform and the inner three metatarsal bones, the latter of the os calcis, cuboid and outer two metatarsals. The lateral arch externally through the base of the fifth metatarsal is in contact with the ground, whereas internally it is not in contact with the ground but gains its support through the ligaments and muscles. The posterior pillar of the antero-posterior arch is made up of the os calcis and astragalus and is quite strong, though comparatively immovable, whereas the anterior pillar of this arch is made up of the heads of the metatarsal bones and is quite movable. This elasticity of the anterior pillar makes it more resistant than the stiff posterior arch against active pressure.

The weight from the body is transmitted from the astragalus to the tuberosity of the os calcis, the heads of the metatarsal bone and to the base of the fifth metatarsal bones. A person falling and landing on his feet is more apt to fracture the os calcis than one of the metatarsals, and if the metatarsals give way the inner ones are more frequently broken than the outer.

The strain of the arch of the foot according to Von Meyer⁶ and others is carried by the second and third metatarsal bones, and this seems to be correct, for according to Tabold's series these two bones were more frequently broken than the others by indirect force, as in marching, jumping, etc.

Lateral deformity in metatarsal fractures has been considered by some not so important as an upward or downward displacement of the fragments, as in the latter boot-pressure may be most annoying. Traumatic flat-foot is

probably the most serious sequela of metatarsal fractures, and this is largely due to a loss of convexity of the metatarsal bones. If it is true that the second and third metatarsals carry the strain of the arch, then a fracture of these bones with a loss of their convexity is almost certain to be followed by static disturbance.

In fractures of the metatarsals, if no marked deformity exists, conservative treatment should be carried out, but if there be deformity sufficient to markedly destroy the convexity of the bones, especially if more than one bone is broken, or the fracture includes the second and third metatarsal bones, then operation should be considered.

Those of us who have done much marching appreciate and know what a blessing it is to have good sound feet, as there is nothing which so quickly disqualifies a person as foot trouble. In all metatarsal fractures we should think of the result, and to obtain a good useful foot it is imperative that the bones be restored as near as possible to their original position.

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CHORIO-EPITHELIOMA FOLLOWING HYDATIFORM DEGENERATION

WITH REMARKS ON THE USE OF RADIUM*

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It is the general belief that chorio-epithelioma and its frequent precursor, hydatiform mole, is of rather rare occurrence. The fallacy of this belief has been so convincingly brought to me during recent months that I have felt a study of this subject might be of interest.

Although when a medical student I saw three cases of hydatiform mole, all followed by malignant chorioma, during a period of fifteen years since, no more cases came under my observation, at least none were so recognized, until in the past eighteen months during which time I have treated four cases of hydatiform mole, while two other cases have occurred in the practice of my colleagues in St Vincent's Hospital during the same period of time. Four of these six cases were followed by chorio-epithelioma, the other two being operated at an early stage while still benign moles.

The prevalent idea of the infrequency of these conditions is probably due to the text of authors long since out of date. For instance, Edgar in his book states that placental mole occurred four times in 15,000 cases. Williams observed five in 5000, while Madame Boivin states that the condition occurs once in 20,000 conceptions. My own experience of the past eighteen months, coupled with a study of the more recent literature, would at once show the fallacy of the old teachings, and convince the student of today the necessity for greater familiarity with the subject and a more watchful attitude in the care of all conceptions, both tubal and uterine.

Meyer states that in 348 pathological uterine abortions the incidence of hydatiform degeneration occurred in 43 per cent, while in 104 tubal pregnancies classed as pathologic the hydatid mole followed in 46 per cent. Meyer's numerous and recent writings cover most completely all sides of this study and he finally states, "Indeed, how many cases of hydatiform degeneration one can find in tubal and uterine abortions will depend very much upon the care with which the examination is made, for the condition is undoubtedly extremely *common* and not rare, as heretofore supposed."

The foetal placenta is developed from the chorion, and through the chorionic villi is derived the nourishment for the foetal organs. These villi are finger-like projections covered on the surface with the layer of syncytial cells, next beneath the cells of Langhans', and then the stroma containing a small number of capillaries. As the placenta develops the villi show rapid

* Read before the Virginia Section of the American College of Surgeons, April 15, 1921

growth and great erosive power by which they are able to penetrate through the uterine mucosa into the underlying venous sinuses, where, by selective absorption, they gain nourishment for themselves and for the placenta. When conditions are normal and the foetus about mature, these villi withdraw from their intra-mural position, the outer layer of syncytial cells covering the villi has long since undergone atrophy, the layer beneath Langhans' cells also undergo degeneration and thus the attachment between mother and foetus is loosened in preparation for birth. But this does not always happen, for some of the villi may persist in intimate contact with the maternal tissues and maternal blood and may continue to grow in situ after the normal period of gestation has been attained. Continuing to be nourished by the maternal blood and to absorb fluid, they may hypertrophy and become distended by an oedematous mucoid infiltration so as to form a mass or series of clear, grape-like vesicles of varying size, distending the uterus to even as great an extent as a full term foetus. Such is the hydatiform mole.

When the above condition remains within normal limits the result is nothing more than a benign mole, this is expelled in due time or is surgically removed, and thereby is explained the fairly frequent cases of hydatiform mole which are followed by repeated normal pregnancies. On the other hand the villous growth may proceed beyond the normal limits, the venous sinuses may become filled with an active proliferation of the chorionic elements, the epithelial cells may be swept away by the blood current and deposited in the capillaries of the vagina, pelvic vessels, lungs and other organs, and thus we have a transition from the benign mole to the highly malignant chorio-epithelioma.

I have already referred to the rather common frequency of hydatiform degeneration found in pathological abortions, both tubal and uterine, but of greater importance is the incidence of malignant chorio-epithelioma resulting from the transition of the epithelial elements of the placenta mole. Briquet, in a series of sixty-five hydatid degenerations, found that malignant chorioma followed in thirty-one demonstrable cases. Pollasson and Violet, in the study of 455 cases of chorio-epithelioma, found that mature hydatiform mole or hydatiform degeneration of pathologic abortion occurred as a precursor in 366 instances. To emphasize the importance of careful examination of all placentas it may be added with stress that these same investigators found ninety-seven chorio-epithelioma followed hydatiform degenerations discovered during labor near term.

With the present unrecognized frequency of these conditions it is not surprising to find that the initial symptoms may first appear as the result of metastases in vagina, lungs or brain, producing thereby a vaginal tumor, cough with hæmoptysis or cerebral apoplexy. The lungs seem to be the most common site for metastasis. In the above quoted series of cases metastases occurred in the vagina ninety-three times, in the brain forty times, and in the lungs 133 times. Ewing, in discussing the rapidity with which malignancy follows hydatiform degeneration, states that the transition usually takes

place about five weeks after labor at term, seven weeks after abortions, and about eight weeks after mature mole. In one of my cases (No. 4), well-developed chorio-epithelioma was found in the scrapings removed one week after the mature mole was discharged.

The maternal mortality of simple placental mole is quoted as 13 per cent by Edgar and 18 per cent by Dorland. This mortality is usually due to hemorrhage or sepsis, and the rate is entirely too high provided these cases can have hysterectomy performed before molar abortion occurs. After malignant transition occurs the mortality rate is quoted about 100 per cent by all authorities. Ewing states that with or without hysterectomy the disease permits life for from six to eighteen months, and further states that he has been unable to find any operative cure of chorio-epithelioma. Adams states that the process is rapidly fatal. Schmauch emphasizes the necessarily fatal issue and advises against operation. Since the primary malignant process always develops entirely within the venous sinuses and capillaries, it would seem almost impossible to avoid displacing intra-vascular fragments during hysterectomy and thus hastening metastasis. On the other hand if this susceptible foetal hyperplasia could be stunned or its growth inhibited by radium, there might be a greater possibility of cure following hysterectomy. This agent was employed on three of my patients, with results in two cases that are both promising and encouraging.

My experiences may be related briefly as follows:

CASE I —A negress with soft symmetrical uterine tumor, carrying a pre-operative diagnosis of fibromyoma, upon whom hysterectomy was done before molar abortion had occurred. This patient is living and well.

CASE II —White, age forty-six, came under my care three weeks after expulsion of the larger portion of an hydatid mole. Fragments of the mole could be extracted with the examining fingers through the patulous os. The general condition of the patient was wretched, a grave secondary anemia following continuous hemorrhage for three weeks, with rapid, feeble pulse absolutely precluded operative interference. 1800 mhrs of radium treatment within the uterus was followed in one week by complete relief from metrorrhagia. In eight weeks the patient was greatly improved with a gain of twenty pounds in weight. At this time bleeding from the uterus recurred, but the general condition of the patient was so good that operative interference was undertaken. Again 1800 mhrs of radium was given as a pre-operative measure within the uterus and forty-eight hours later pan-hysterectomy was performed. The specimen removed showed a well localized, perforating chorio-epithelioma in a state of regression and degeneration. Eighteen months has elapsed since this patient expelled the mole and she is now living and apparently well.

CASE III —White, age forty-two, presented about the same problem as Case No. II, coming under my care for continuous and depleting uterine hemorrhage following molar abortion five weeks previous

Fragments of the remaining hydatiform mole removed with placental forceps showed no evidence at that time of malignancy. The same radium dosage was employed and the hemorrhage promptly checked, but returned again in five weeks. Profiting by the experience of Case No II, I did not wait for better general improvement, but operated forty-eight hours after a second radium application of 1800 mhrs within the uterus. The specimen removed disclosed a more widespread area of chorio-epithelioma than in Case No II, but the entire pathological process showed marked destructive and degenerative action from the radium. Eleven months have elapsed since this patient was first treated by radium and she remains well to this date.

CASE IV —This case is recent. Seven days after expulsion of a huge hydatid mole the scrapings from the uterus showed well-developed chorio-epithelioma and the fact that the accompanying hemorrhage promptly yielded to radium within the uterus. The general condition of this patient is too precarious at this time to permit of radical operative measures.

I have just received data of a case in the practice of one of my colleagues in which a smaller dosage of radium, 400 mhrs, checked the bleeding and apparently relieved the patient of all symptoms following the expulsion of the benign mole four months ago.

CONCLUSION

The frequency of hydatiform degeneration and the ready transition into chorio-epithelioma should counsel every practitioner to be on the alert especially in pathologic abortion, both tubal and uterine. A more extensive experience with radium in these conditions may lend hope in the treatment of the malignant transitions which heretofore have been considered necessarily fatal.

Additional justification for this hope may be found in the recognized susceptibility of embryonal structures to radium, especially if used early, for Ries has reported intact villi in a uterine sinus eighteen years after the last labor and the latency of malignant chorio-epithelioma, one, three, five and even ten years has been established by the literature.

PERFORATED GASTRIC AND DUODENAL ULCER WITHOUT PREVIOUS PAIN

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AND

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RECENTLY, in reviewing our histories of perforated gastric and duodenal ulcer, we found that four of fifteen cases in which our histories were complete, or 26 per cent. of them, were instances where perforation was the first sign of abdominal pathology. This was the incentive for the writing of this paper, since we have not been able to find any paper discussing the subject entirely from this point of view.

It has been the observation of every surgeon of experience in abdominal surgery that there are two types of gastric and duodenal ulcers, the typical and the atypical. It is only the first variety with its hyperacidity, pain associated with regurgitation and vomiting, and a tendency to spastic constipation, that can give a history of importance in the diagnosis of an acute perforation. Errors in the diagnosis of this type, if seen before a diffuse or generalized peritonitis has developed, do not and should not frequently occur. In the atypical variety, however, which may or may not be associated with hyperacidity and which may not be accompanied by pain, it is often impossible to make an exact diagnosis, for the perforation may come on as the first sign of a latent ulcer.

The explanation of the presence or absence of pain in ulcer depends upon a knowledge of the anatomico-physiological reflex of gastric and duodenal pain. It is necessary to know the innervation of the stomach and duodenum in order to understand this reflex. The stomach and duodenum receive their innervation from two separate and distinct systems, that is, the para-sympathetic and the sympathetic systems. These systems together with the sacral para-sympathetics compose the autonomic system. The autonomic motor nerve cells which innervate all involuntary muscles were originally like those nerve cells of the voluntary muscles situated within the central nervous system, and correspond to the anterior horn cells of that system.

The main para-sympathetic nerve is the vagus, which is distributed to the heart and to the alimentary canal and its outgrowths. The vagus connector fibres to the alimentary tract have their terminations in a group of motor cells situated between the circular and longitudinal muscles of the stomach and intestines which are known as Auerbach's plexus. Bayliss and Starling, working along the line suggested by Gaskell, have demonstrated that both the longitudinal and circular muscles contract upon stimulation of the vagus and that neither contract upon stimulation of the sympathetic nerve. Thus we see that the vagus is the dominant factor in both the motor

and secretory innervation of the stomach and duodenum. As Gaskell has pointed out, however, the vagus supplies motor fibres only to those alimentary muscles which are of endodermal origin. It initiates the sensation of hunger and the secretion of gastric juice, it plays an important rôle in gastric and duodenal peristalsis, and it maintains the tone in these viscera.

The sympathetic nerves, on the other hand, have an antagonistic effect on the vagus, in that they are inhibitory to the endodermal musculature, and motor to the dermal musculature of the intestinal tract. There is no evidence that the sympathetic motor fibres reach as high as the oesophagus. The present evidence would lead us to believe that the cardiac incisure of the stomach is the upper limit of sympathetic supply.

To sum up then, we have two antagonistic systems concerned in the region under discussion. The vagus (para-sympathetic or cerebral autonomic) supplies the cardiac sphincter and cardiac end of the stomach with both motor and inhibitory fibres and also motor fibres to the pyloric half of the stomach and to the duodenum. The sympathetic (splanchnic or thoracico-lumbar) supplies the pyloric half of the stomach and the duodenum with inhibitory fibres and the pyloric sphincter with motor fibres. This intricate arrangement gives us our best example of reciprocal innervation and physiological antagonism.

Bayliss and Starling have shown that when any part of the alimentary tract is stimulated to contraction the part below relaxes, and they call this "the law of the intestine." Meltzer termed this the "law of contrary innervation," and applied the term to the entire alimentary canal. Its action is seen normally in the relaxation of the sphincteric orifices when peristaltic waves from above approach them. Elliot, in his "Law on Innervation of Hollow Viscus," said, "When the quiet lodgment of contents is facilitated by the presence of sympathetic inhibitory nerves to the body of the viscus, there will also be sympathetic motor nerves to the sphincter closing the exit." Thus Elliot was the first to show that, whereas in the stomach sympathetic inhibitory impulses are antagonistic to peristalsis, the sphincter will be innervated by motor fibres from the same system.

Up to this point we have spoken of the autonomic system as a complete nervous system, but this is in reality not the case. Langley and Gaskell have shown that all the afferent fibres of the autonomic system have their cells in the posterior root ganglia. The course of the afferent or sensory nerves is therefore the same as in the sensory portion of the spinal nerves of the cerebro-spinal system, and they have no demonstrable connection with the cells in the sympathetic ganglia.

When we consider the cause of ulcer pain we must consider the subject of visceral pain in general. One of the supposed causes of ulcer pain is that ascribed to a hyperacid gastric juice, acting on the exposed nerves in an ulcer base. This theory is not reliable, since we occasionally see patients with typical ulcer pain who at operation have "healed ulcers" and only scar tissue remaining. Einhorn has also pointed out that some patients have

ulcer pain with an associated achylia gastrica Hurst, in attempting to solve this question, introduced four ounces of a 0.5 per cent solution of hydrochloric acid into the empty stomachs of each of six patients, in all of whom the diagnosis of gastric ulcer was later confirmed at operation, with no sensation resulting. This same result occurred when a mixture of hydrochloric acid and pepsin was used. It is certain that as much as 0.5 per cent of free hydrochloric acid is never present in the stomach. This undoubtedly proves that contact with free hydrochloric acid is not the direct cause of pain in gastric and duodenal ulcer.

The relief offered by alkalis suggests that the pain is in some way associated with the presence of free hydrochloric acid. Very few afferent nerve endings are found in the mucosa, the majority terminating in the submucous and muscular coats. Hyperacidity stimulating exposed nerve endings in an ulcer base sets up an excessive reflex motor activity. This was pointed out by Edlemann working in Pavlov's laboratory who found the peristaltic activity proportional to the amount of acid present. In the following explanation of the cause of pain in gastric and duodenal ulcer we are accepting Hurst's theory of tension as being the only adequate stimulus producing visceral pain. It is well known and we have recently demonstrated to ourselves that the gastric mucosa is insensitive to the usual painful stimuli such as pricking, pinching and cutting. This has been observed by any surgeon who has performed a gastrostomy under local anaesthesia. Hurst has shown that Lennander and Mackenzie did not take into consideration that a nerve ending may be sensitive to one form of stimulus—the adequate stimulus—but insensitive to all others. According to Langley the painful sensations of the stomach and small intestines are conveyed by the sympathetic and not by the vagus. On the other hand Miller, in 1911, proved that motor and secretory reflexes which resulted from irritation of the gastric mucous membrane depend on afferent impulses carried by the vagus and not by the sympathetic. It is to be presumed that the afferent nerve-endings are more strongly stimulated when they are exposed in an ulcer base than when the mucous membrane is intact. This is also in accord with our knowledge that a greater number of afferent nerve fibres pass from the deep structures of the gastric wall, which are exposed when there is ulceration of the mucous membrane. These findings correspond to the demonstrations of Head that referred pain and tenderness in gastric and duodenal ulcer is almost always found in the distribution of the seventh, eighth, and ninth dorsal segments, with which segments the afferent sympathetic nerves of the stomach and duodenum have their central connection. Reflex pain through the vagus must be expressed in the distribution of the trigeminal, because of the termination of the afferent vagal fibres in the trigeminal nucleus. Thus pain and the associated symptoms of gastric and duodenal ulcer may be explained on the basis of disturbance of Meltzer's "law of contrary innervation."

The increase in peristalsis associated with hyperchlorhydria and the prolonged inhibition of pyloric relaxation which occurs when the hyperacid

chyme reaches the duodenum can only cause real pain when food is present in the stomach, as no rise in intragastric pressure can occur when there is nothing in the stomach upon which the muscular coat can contract. Assuming that ordinarily in a gastric ulcer the pylorus does not relax as the increased peristaltic waves approach it, we have a gradual increase in intragastric tension as the segment between the peristaltic contraction and the point of obstruction is shortened by the advance of the former. This results in violent pain, the result of tension on the muscular coats produced by an enormous rise in intragastric pressure.

Pain does not frequently result from distention of the entire stomach, but more commonly results from segmental distention. Cannon has shown that the cardiac end of the stomach is a receptacle for holding food and the active churning movements are confined to the pars pylorica. The peristaltic movements begin at the cardiac incisure and deepen as they move toward the pylorus. Just above the pyloric canal they deepen to such a depth that part of the pyloric vestibule becomes almost completely separated from the upper gastric cavity. As the peristaltic wave progresses this cut-off portion diminishes in size, which results in a part of the segmental contents being forced through the pyloric canal and the remainder back into the general gastric cavity. Normally, the internal gastric pressure in the pyloric end of the stomach which is necessary to force chyme through a relaxed pylorus is insufficient to cause sensation. But when due to abdominal pathology the peristaltic waves are more frequent and of greater intensity, they begin nearer to the fundus of the stomach than usual and they also separate the pyloric end of the stomach from the rest of the organ at a point more distant from the pylorus than under normal conditions. This increased peristaltic activity results from the hyperchlorhydria, plus the presence of the ulcerated area. The result is a larger quantity of chyme being compressed as each wave advances. This, together with the inhibition of pyloric relaxation which occurs, as Pavlov has demonstrated, when the hyperacid chyme reaches the duodenum, affords a sufficient rise in intragastric tension to produce pain. This pain increases as the peristalsis becomes more active, and as the pyloric relaxation is inhibited for longer periods by a gradually increasing hyperacid chyme reaching the duodenum.

The time relations for the onset of pain are easily explained if we consider at what moment free hydrochloric acid comes into contact with the ulcerated area so as to lead to an exaggeration of the reflex motor stimuli which produce pain. Hydrochloric acid is secreted chiefly by the glands in the upper two-thirds of the stomach, the extreme pyloric end as Langdon Brown has shown being actually alkaline. Carbohydrate digestion continues for some time in the fundic portion of the stomach, but protein digestion is very slow. This slow protein digestion is not due to a lack of hydrochloric acid, but it is due to the absence of peristalsis which prevents a mixture of the contents in this region. The outer layer of chyme, because of this lack of churning, is therefore quite acid. When an ulcer is present in the cardiac

PAINLESS GASTRIC ULCERS

or fundic region, this hyperacidity sets up hyperistalsis which begins very high in the stomach. This accounts for the nearly instantaneous pain in upper gastric ulcer. Food reaching the pyloric end of the stomach is alkaline, and remains so for a considerable period of time after ingestion. This is due to the active peristalsis in the pyloric portion constantly mixing the food and gastric juice which form chemical combinations with each other. Therefore an hour or more may elapse before there is sufficient free acid to irritate an ulcer near the pylorus.

The pain may begin or be more intense several hours after a meal. Here it is due to an increase in the tone of the stomach as that organ empties itself. This allows the pyloric end of the stomach to be closed off more completely from the upper gastric cavity and the result is increased intragastric tension of the lower segment.

Hurst in a series of cases of duodenal ulcer examined by the X-ray found that the stomach begins to empty itself immediately after the food swallowed reaches it. The stomach, as X-ray observations show, is hypertonic, and the gastric contents are at first extruded with such rapidity as to give to the action the name "duodenal rush." Thus at the time a patient is free of pain after the ingestion of a meal, food is actually passing over the ulcer. Due to the excessive and prolonged secretion of normal gastric juice, causing the so-called hyperchlorhydria of duodenal ulcer, the proportion of gastric juice and hydrochloric acid in the chyme increases as digestion proceeds. At first, as in gastric ulcer, this acidity is neutralized by combination with the alkaline salts and protein in the food, to which are added the alkaline bile and pancreatic juice. This results in only an occasional pyloric inhibition, but after two or three hours the proportion of acid being greater, some of it reaches the ulcer without being neutralized and the inhibition of pyloric relaxation is accentuated. The X-ray examination now shows a small amount of food in the stomach with the gastric hypertonicity at its maximum, having increased as the bulk of gastric contents decreases. Long after the fundus has returned to a fasting condition, the pyloric portion contains food and shows very vigorous peristaltic action. This again brings about the condition where peristaltic contractions can produce a complete separation of the pyloric part from the rest of the stomach at a considerable distance from the pylorus. Thus we may have three favorable factors for the production of pain, hypertonicity, excessive peristalsis, and inhibition of pyloric relaxation, the pain persisting until the stomach is empty.

In both gastric and duodenal ulcer we may, as we have already said, have a true reflex pylorospasm which may cause a delay in the emptying of the stomach and in this manner cause a hyperchlorhydria. In other words pyloric spasm may produce hyperchlorhydria and hyperchlorhydria may produce a reflex inhibition of pyloric relaxation.

When we come to explain those atypical cases with perforation as the first sign of abdominal pathology, we find a group of cases in which, as Eppinger and Hess have stated, gastric hyperacidity does not occur, which are

not accompanied by pain or eructations. Some of these are only found at autopsy. These patients are probably the cases described by C. H. Mayo as individuals with "hypo-sensitive abdomens." In them we find signs of a depression of vagus and sympathetic reflexes, with no hyperchlorhydria, no pyloric disturbance, and therefore no pain. It is well known that different individuals react in varying degrees to the same external stimulus, and there is no reason why this observation should not apply to visceral stimulation. We have in the following cases a raising in the threshold of the conscious perception of pain. In them the same strength of stimulus which in a typical case gives rise to the usual symptoms, does not cause abnormal reflex motor and secretory activity, and we do not have symptoms. Therefore these are the cases of ulcer in which there is no disturbance of "law of contrary innervation," and in which with every peristaltic wave the pyloric sphincter functions normally.

CASE REPORTS

CASE I—W. M., age fifty-five, admitted to University Hospital, July 12, 1910. Until 10 A. M. he was perfectly well, never having had any previous abdominal symptoms. On admission entire abdomen was rigid, temperature 98.3, pulse 90, respirations 28. Operation by Dr. Muller disclosed a perforated duodenal ulcer which was sutured. No posterior gastroenterostomy was performed. Recovery uneventful and the patient was discharged on August 17, 1910.

CASE II—M. W., age thirty-two, admitted to the Misericordiae Hospital, September 28, 1918, complaining of severe abdominal pain. He had never had abdominal symptoms until 4 P. M. of the previous day, when he began with generalized epigastric pain and vomiting. On physical examination the rigidity and tenderness simulated appendicitis. Operation by Dr. Muller: McBurney incision, appendix only slightly inflamed and not sufficient to cause the general fluid present in the abdomen. Appendix removed, wound closed, and right rectus incision made. All around the pylorus and duodenum was found a plastic yellow exudate and small pockets of fluid. No perforation could be discovered through the exudate. A posterior gastroenterostomy was impossible because of edema of the lower part of the stomach. The space between the liver was drained with two rubber tubes. The patient made a good recovery.

CASE III—Mrs. J. V. R., age seventy-two, admitted to the Reading Hospital, September 30, 1918. Five days ago she was seized with acute abdominal pain and constipation. Cathartics were ineffectual. Patient had marked distention and borborygmi. Never had had abdominal symptoms before. Operation by Dr. Muller, September 30, 1918. A perforation of the anterior wall of the duodenum about two and one-half inches from the pylorus was found and sutured. No drainage was introduced. Recovery uneventful.

CASE IV—W. W., age thirty-two, admitted to the Medico-Chi Hospital, November 19, 1920. About 4 P. M., which was three hours after eating an egg sandwich, the patient was suddenly seized with

PAINLESS GASTRIC ULCERS

acute generalized abdominal pain followed by vomiting No previous history of any abdominal discomfort Abdominal muscles rigid, some peristalsis, leucocytes, 22,000 Operation by Dr Ravdin A perforated duodenal ulcer, about two inches below the pylorus, on the upper duodenal wall, was found This was sutured and a posterior gastroenterostomy was performed Recovery uneventful

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POLYPOID LIPOMA OF THE INTESTINAL TRACT

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THIS paper is based on the report of a case of lipoma of the ileocecal junction. The literature and the Bellevue Hospital records on this subject were also reviewed.

CASE I—D O, male, aged fifty-three years, Ire. Admitted to Bellevue Hospital May 28, 1920, complaining of pain in and about region of umbilicus. Four weeks before admission he began to have pain around navel. The pain would last from four to five seconds and feel like a sense of compression. He has been having several of these attacks every day. No blood in the stools. No belching of gas. No jaundice. No headache or impairment of vision. No genito-urinary or cardiovascular symptoms. No recent loss of weight. The patient has had a mass in the right inguinal region since a child. The mass often disappears by itself. At other times he can make it disappear. He was born without testicles in the scrotum. He is a well-developed male, well nourished, not acutely ill.

In the left side of the abdomen there is an oblong mass apparently involving the sigmoid, splenic flexure and descending colon. The abdomen is distended. The mass is evidently related to his attacks of pain.

May 30th had considerable pain in epigastrium. Bowels moved three times. Stool examined. Blood present. Abdomen distended, tympanic but not rigid. The oblong mass persists in the left lower quadrant. No peristalsis seen.

Radiographic Report (June 4th)—No evidence of any obstruction of any portion of the colon. The colon is characterized by a central loop of the transverse portion. The haustra formation is very large. There is no defect in the outline.

Operation Exploratory Celiotomy (June 7th)—*Resection of the ileocecal junction, end-to-side anastomosis*. A tumor mass was found in the abdomen in the region of the splenic area. On drawing it into the wound it was found to be an intestinal growth springing from the ileocecal junction. The mass itself was in the lumen of the intestine, apparently arising from the mesenteric attachment of the ileum and extending into the lumen of the large intestine. It was pyriform in shape, measuring about 7 x 6 x 5 cm, and having a distinct pedicle which infiltrated through the mucosa into the muscularis and serous coat of the intestine (Fig 1). The free end of the mass had several small-sized knobs and cysts on it. At one side of the base there was a small bare area through the mucosa. Several large palpable lymph-nodes were found in the mesentery near the ileocecal junction. The appendix was

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quite long, congested and appeared pathological. There was no evidence of any intussusception at the time of the operation.

Procedure—A 7 cm median laparotomy below the level of the umbilicus was done. The tumor was found in the splenic region and brought into wound easily. After intestinal clamps had been applied above and below the ileocecal junction, an attempt was made to remove the growth through an incision in the lower ascending colon as the tumor was thought to be wholly cecal in origin. On opening the cæcum the pedicle was found to be implanted in the ileum and on trying to enucleate it, it was found that the growth extended through all three coats, and therefore a resection of the ileocecal junction was decided upon. We also had found several fairly large lymph-nodes in the mesentery close by, and the general appearance of the tumor mass made us believe the growth to be a malignant one. The resection of the cæcum and terminal ileum was accomplished fairly easily and an end-to-side anastomosis was done, implanting the ileum into the cæcum at the site of the original opening in the ascending colon. A large cigarette drain was introduced and the abdominal wall sutured in the usual manner. Condition of the patient at the end of the operation was good.

Pathological Report (by Doctor McWhorter)—Two specimens. One an apparently encapsulated tumor-like mass which measures 7 x 6 x 5 cm. The outer surface of this mass is covered with a large number of nodule-like projections which vary in size and shape. The whole surface appears to be covered by mucous membrane except one area. This tumor-like mass is attached to the surrounding tissue by a large thickened pedicle which measures 3 cm in thickness. On section this specimen is seen to be surrounded by a rather thin dense outer covering. The substance of the tumor is composed of a soft yellowish tissue which resembles fat. The pedicle is made up of a very dense mass of connective tissue. The other specimen was the resected ileocecal junction. In the mass of tissue surrounding the intestine, there are a number of enlarged lymph-nodes which on section are of relatively normal appearance (Fig. 2).

Microscopical Examination—Sections from the pedunculated tumor mass show the whole outer surface to be covered by mucosa, the glandular tissue of which in places is hyperplastic, while in other areas it is greatly hypertrophied. This glandular area is supported on a layer of connective and muscular tissues which somewhat resemble the normal muscularis. Extending inwards from this surface the tumor is entirely made up of a mass of adult fat which extends throughout the sections and is limited by the wall on the other side. Sections from the pedicle show a layer of dense tissue which somewhat resembles the muscularis. Beyond this there is a compact somewhat cellular mass of connective tissue which makes up the supporting pedicle. Sections show no evidence of malignancy.

Post-operative Course—Patient had a slight post-operative reaction, developing some pulmonary congestion for several days, which gradually disappeared. The wound discharged for several weeks, at first the discharge being quite foul, but later with Dakinization of wound it cleared up rapidly.

He was discharged a month after the operation with the wound

healed and solid abdominal wall His appetite was good, bowels regular and no blood in stools

Follow-up Note (January, 1921) —Patient has gained about twenty-five pounds since the operation, feels fairly well, eats well, sleeps well, bowels regular without cathartics Scar is solid, no evidence of post-operative hernia Right inguinal hernia still present

This case was extremely interesting from several viewpoints, anatomically, pathologically, and clinically Anatomically, the patient showed distinct signs of incomplete development as evidenced by the undescended testicles, the congenital hernia, and the apparent incomplete rotation of the large intestine as shown at operation by the finding of the ileocecal junction in the splenic region and the presence of a long mesentery attached to the first portion of the ascending colon Pathologically, the tumor as a gross specimen had all the appearance of a malignant growth, but on section and microscopically no evidence of malignancy could be found Clinically, the extreme rarity of this condition and the difficulty of making a diagnosis on account of the position of the palpable mass and the clinical symptoms it gave

REVIEW OF THE LITERATURE ON LIPOMA OF THE INTESTINAL TRACT

Pathology —Lipomata may be developed from the submucous coat of the intestine and grow inwards or from the subserous layer and project outwards into the peritoneal cavity¹ They may occur anywhere along the intestinal tract, but seem to be more commonly found near the ileocecal valve They are usually single, but they may be multiple Their size varies and they may be smooth, nodular, or lobulated Senn² quotes Turner as having seen a fatty tumor the size of a walnut growing in the submucous tissue of the large intestine and projecting into the lumen of the bowel near the ileocecal valve Ewing³ also reports having observed a large fatty tumor 4 x 10 cm surrounding the appendix which was the seat of chronic inflammation Bland-Sutton⁴ quotes Stabb who describes a tumor somewhat like ours The tumor rose near the ileocecal valve and in size and shape it resembled three acorns conjoined at the cups It had caused an intussusception of the bowel, this was reduced at the operation and the tumor excised Unfortunately, the mucous membrane sloughed and the patient died

Gant⁵ reports one case of a lipoma of the rectum It was as large as a walnut and was attached to the rectal wall by a pedicle about 10 cm from the anus

The size of the tumor in our case was about 7 x 6 x 5 cm and was pyriform in shape, and on its distal end it had many different sized nodules on it The tumor itself had invaginated into the cæcum through the ileocecal valve.

These lipomata are considered extremely rare, being usually encapsulated and pedunculated, the pedicle infiltrating itself into the muscularis and connective tissue of the intestinal wall None are reported as having shown any malignant changes Ewing states Dewis collected forty-four cases of intestinal lipomata while Ehrlich collected fifty-two Going over the Bellevue

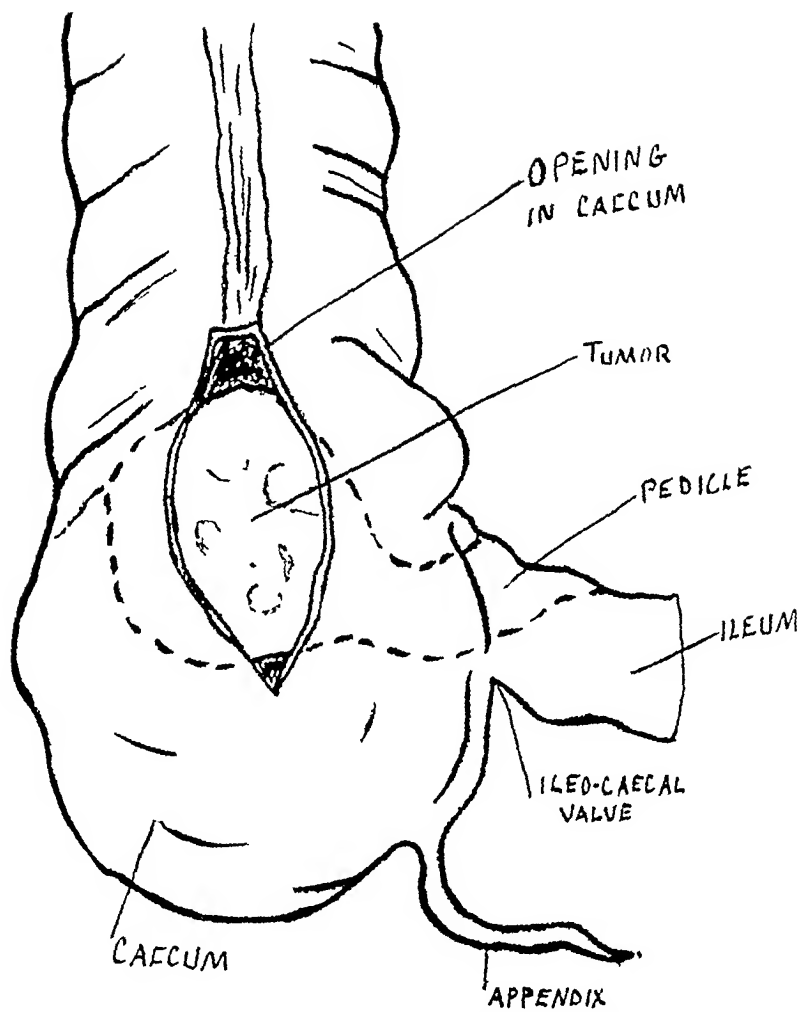


FIG 1 —Diagram showing ileocecal junction with opening in it disclosing the tumor free in the cecum. The rest of the tumor is shown in outline the pedicle going through the ileocecal valve and is attached to the terminal ileum



FIG 2 —Cross section of growth actual size The lipoma is distinctly shown to be circumscribed and completely covered by mucous membrane The pedicle is also quite thick and infiltrates the intestinal wall

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Hospital records from 1911 to 1920 we could only find one other case somewhat similar to ours. We examined the records of 601 cases of benign tumors that had been operated on. Of these eighty-five were lipomas, but none of them was intraabdominal. There were ninety-three cases of papillomas, nineteen being rectal polyps. None of the other benign tumors was found in the intestinal tract. We then examined the records of 120 cases of intestinal obstruction due to intraabdominal causes. Two of these were due to a malignant growth in the wall of the gut. There were twenty cases of intestinal intussusception, two of which were also due to a malignant growth in the wall. One case of intussusception was apparently due to a lipoma of the serous side of the intestine. On account of its similarity to ours it is reported in detail.

CASE II—E. W., female, aged forty-three years, was admitted to Bellevue Hospital in Dr. C. McGuire's service on November 7, 1919, with the diagnosis of acute intestinal obstruction. She had been suffering from severe abdominal pain for four days. She stated that about three months ago she began to have severe abdominal pain, more pronounced in right lower quadrant, was nauseated but did not vomit. Pain would last about one day and would be relieved by a bowel movement. She would be free from pain for three or four days, sometimes a week. For the last month the pain has been more severe, more frequent every three days or so, the last attack being accompanied by vomiting. The patient claims this vomitus was brownish in color and had a horrible taste. Noticed blood in stools two weeks ago and twice since. Has not been able to retain food for the last three days.

Past History—Negative except for removal of uterine tumor eight years ago.

Physical Examination—Obese, well-developed woman in some pain. Temperature, 100°, pulse, 78, respiration, 24. Moderate distention of abdomen. No evidence of free fluid. No visible peristalsis. Tenderness on deep pressure, also rebound tenderness in right lower quadrant. No rigidity, no masses, no costovertebral tenderness. Pelvic examination negative. Rectal examination negative.

Operation (November 9, 1919)—Abdominal incision revealed an intussusception of the colon starting just distal to the hepatic flexure and ending at the first part of the sigmoid. The intussusception was gangrenous for about two inches at its apex. There was no polyp or growth in the lumen of the gut, but the apex of the intussusception had *on its serous surface a large round mass of pedunculated fat*. Many adhesions were present at the hepatic flexure. The sigmoid distal to the intussusception was collapsed. There was a good deal of free fluid in the right lower quadrant and it had a foul odor. A resection of the intussuscepted portion and a side-to-side anastomosis of the colon was done.

November 10th patient developed symptoms of paralytic ileus and a colostomy was done.

November 12th, died.

Pathological Report—Specimen consists of a circumscribed apparently encapsulated lobulated mass which measures 8 x 9 cm. The outer surface is smooth yellowish in color. Attached to one surface there is a mass of brownish rather dense tissue. Section from the tumor mass is very soft yellowish in color and resembles fat. Microscopical section shows mass of adult fat to which is attached part of colon.

SYMPTOMATOLOGY—As can be readily appreciated, these tumors do not give any symptoms *per se* except possibly a palpable mass in the abdomen. But as soon as they obstruct the lumen of the intestine or possibly cause an intussusception, then the symptoms of intestinal obstruction develop. These may be mild or acute, according to the degree of obstruction. During these attacks a mass is usually felt in the abdomen which may be the tumor itself, but more probably is obstructed feces or the intussuscepted mass. The symptoms then may aggravate themselves as the obstruction becomes more complete and finally acute strangulation may occur. During one of these severe attacks the tumor may be expelled spontaneously by rectum. Dewis, in his forty-four collected cases, found that the tumor had been expelled spontaneously in nine and that intussusception had occurred in twenty-one cases.

In our case the symptoms were more of an intermittent obstruction type, due probably to the fact that the tumor arising from the ileum and having invaginated itself through the ileocecal valve it would at irregular intervals obstruct the flow of intestinal contents. As the peristaltic waves would force the tumor through, it must have necessarily caused a beginning intussusception of the ileum into the cæcum. As the muscular action would let up for one reason or another, the tumor would drop back and the intestinal flow would be reestablished.

Diagnosis—A positive diagnosis is practically impossible except possibly in the cases where the tumor is expelled by rectum. In the other cases the diagnosis will depend on the degree of obstruction, and therefore the most likely diagnosis will be either an intestinal obstruction due to a benign growth or an acute intussusception.

Radiographic examination of the intestinal tract may be of assistance or not, according to the amount of distortion the growth may cause in the outline of the gut. In our case neither the tumor nor any irregularity in outline was present in any of the radiographs taken.

SUMMARY

Clinically, therefore, these tumors may pass unnoticed, or their first symptom may be that of acute intestinal obstruction. Usually, though, the symptoms are more of an intermittent intestinal obstruction with acute exacerbations at infrequent intervals. A mass in the abdomen can be felt at times, especially when the symptoms are acute, but in most cases it disappears as these subside. As time goes on the attacks become more severe and may be accompanied by the passage of bright red blood by rectum, and finally complete obstruction occurs with all its attendant symptoms.

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At operation the operator must be guided by his pathological findings. The ideal operation would be an enucleation of the growth from the intestinal wall, but it may be necessary to do a resection of the intestine. This is due to the fact that on careful examination the pedicle of the growth is found to involve all the three layers of the intestinal wall. The resection should, therefore, be wide enough of the growth so that the whole pedicle will be removed. Other points to be considered in the resection, are the condition of the gut at the time of the operation, that is, if there is any intussusception of the intestine. In these cases the amount of resection would depend on the viable condition of the gut. Another condition to be considered is the location of the growth itself, for instance. If it is near the ileocecal junction, as in our case, it would be advisable to resect, as it would obviate the possibility of a constriction at an already narrow passage.

The post-operative course will again depend on the operative findings. If there was no obstruction the course will probably be a smooth one. If, on the other hand, there was an extensive obstruction and possibly an intussusception, the reaction will depend chiefly on the complicating conditions.

In closing I wish to express by thanks to Dr F St John, Director of the First Surgical Division of Bellevue Hospital, for the privilege of reporting this unusual case.

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MYOMA OF THE RECTUM

REPORT OF FOUR CASES

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VERY few cases of benign tumors of the intestinal tract are reported in the literature Heurtaux, Steiner, Dewis, King and others have written extensively on the subject, however, and have published cases of their own

The tumors originate from the part of the intestinal wall which corresponds to the histologic structure of the various tumors, for example, adenomas from the mucosa, fibromas from the submucosa and serosa, lipomas from the fat cells of the external coat and from the appendices epiploicæ, angiomas from the vessels of the intestinal wall, and myomas, according to most investigators, from the muscularis or muscularis mucosa In the benign tumors reported in the literature adenomas are the most frequent, angiomas most infrequent, and myomas comparatively infrequent

In King's series of 119 cases the ileum and rectum are most often the sites of benign tumors Dewis, in 1906, found 219 benign tumors of the intestinal tract, of which 101 were in the rectum, there were 81 adenomas, 10 myomas, 6 lipomas, 2 fibromas, and 2 angiomas In Dewis' series were 40 myomas, 10 in the rectum and 30 in the remainder of the intestinal tract In 1917 King reported a series which contained 45 myomas, of which 11 were in the rectum

True myomas or pure muscle tumors are exceedingly rare, most tumors designated myomas contain varying amounts of connective tissue, and, depending on the relative amount of muscle and fibrous tissue, they have been called myomas, myofibromas, and fibromyomas The first true myoma of the rectum diagnosed as such was reported by Vander Espt in 1881 However, in 1872, Malassez had described a tumor of the rectum showing the structure of a myofibroma In an extensive review of the literature only twenty cases have been found since 1872 which can be classified definitely as myoma or myofibroma of the rectum

Myomas have been found throughout the entire gastrointestinal tract Steiner collected twenty-one cases of myomas and myosarcomas of the stomach The structure of these tumors is quite analogous to that of myomas of the uterus, and it might be supposed, because of the close proximity of the uterus and rectum, that the tumors in women are uterine in origin, however, the uterus was not found to be the origin in any of the reported cases In eight instances the tumor originated from the anterior rectal wall, and in five instances, from the posterior wall The part of the rectum involved in the others was not stated The

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tumors varied in size from about 2 cm in diameter to 12 pounds in weight, the largest extended down over the buttock, and was about 15 cm in diameter

Rectal myomas have been classified internal or external, according to their projection into the lumen of the bowel, or externally into the perirectal structures. Six were definitely pedunculated and extended into the lumen of the bowel, the remainder, apparently, were deeply imbedded and only encroached on the rectal lumen.

Many benign tumors of the intestinal tract are slow growing and symptomless, these are usually discovered accidentally in routine physical examinations or during operations for other conditions. Symptoms, when present, are usually mechanical, and are those of partial or complete obstruction, or hemorrhage occurs because of erosion. The predominating symptoms in the twenty cases were constipation, hemorrhage, and pain.

SYMPTOMS

	Cases
Constipation	12
Hemorrhage	7
Pain	7
Rectal pain	6
Abdominal pain	1
Obstruction	3
Rectal irritation	2
Desire to stool	2
Sensation of mass in rectum	2
Tumor known to be present	4
No symptoms	3

The infrequency of intestinal obstruction, considering the size and location of some of these tumors, is striking.

The diagnosis was based on microscopic findings in ten cases, the diagnostic data were not stated in ten.

DIAGNOSIS

	Cases	Microscopic	Not stated
Myoma	5	3 (Cases 2, 9, 15)	2 (Cases 3, 20)
Fibromyoma	12	5 (Cases 7, 8, 12, 14, 17)	7 (Cases 4, 5, 6, 10, 13, 16, 19)
Leiomyoma	2	1 (Case 11)	1 (Case 18)
Myoid	1	1 (Case 1)	0

The diagnosis in the four cases here reported was made by microscopic examination. Two of the tumors were true myomas and two were fibromyomas. In these cases, constipation, difficulty at stool, and hemorrhage were the predominating symptoms. In one case bleeding had been profuse to the extent of reducing the hæmoglobin to 20 per cent at the

time of examination The tumor originated from the anterior rectal wall in two cases and from the posterior rectal wall in two cases

In the series of 20 cases reported in the literature and the 4 cases in the Mayo Clinic, 13 were females and 10 were males, the sex was not stated in one case The youngest patient was twenty-one and the oldest eighty-five years, the average age was forty-five and three-fifths years

AGES BY DECADES

	Cases		Cases
21 to 30 years	2	51 to 60 years	3
31 to 40 years	6	61 to 70 years	1
41 to 50 years	10	85 years	1

The tumors are often slow growing and may be present for years without symptoms The duration of symptoms was stated in fifteen of the cases in the series

DURATION OF SYMPTOMS

			Cases
Shortest	a few weeks		
Longest	5 years	2 years	3
		3 years	3
Less than 6 months	4	4 years	2
Less than 1 year	5	5 years	2

Malignant change may occur, it was seen in Case A55082 Ulceration of the overlying mucosa was a striking finding, but it is not diagnostic of any tumor of the rectum The differential diagnosis includes all the benign tumors of the rectum and usually cannot be made accurately without microscopic examination A smooth overlying non-infiltrated mucous membrane often is present and favors a diagnosis of benign tumor rather than malignant In our cases there was a tendency to ulceration, and in one case extensive excavation into the perirectal tissues The tumors tend to recur, usually due to incomplete removal or malignant change

ABSTRACTS OF CASES IN THE LITERATURE

CASE I (reported by VANDER ESPT) —A woman, aged twenty-one years, in the seventh month of pregnancy noticed blood in the stools She had also felt a tumor in the anus At the time of delivery the tumor, about 3 cm in diameter, appeared at the anus, it was smooth and bled easily from the covering of mucous membrane The growth was removed by tying off the pedicle Microscopic examination revealed smooth muscle fibres, and the growth was called a myoid

CASE II (reported by TEDENAT) —A man, aged forty-six years, entered l'Hotel Dieu de Lyon January 5, 1876 The patient was a full-blooded, vigorous man, who had lost blood from time to time during the preceding four years Several hemorrhages had been very severe He had had obstinate constipation, with a sensation of weight in the rectum, for five or six months before he came under observation December 25, 1876, after he had been five days without bowel movement his abdomen was distended and tender to pressure and he had severe colic Examination disclosed a hard tumor, about 0.5 x 1 x 2 cm, situated 5 or 6 cm above the anal margin on the pos-

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terior wall On cutting the tumor after its removal, irregularly disposed bundles of fibres and a few smooth muscle fibres were shown A diagnosis of myoma was made The patient made an uneventful recovery

CASE III (reported by BERG) —A man, aged fifty-six years, had been constipated for about ten years, and had had several severe rectal hemorrhages Rectal examination disclosed a hard, round tumor, extending into the posterior wall and encroaching on the rectal lumen The overlying rectal mucosa was ulcerated The tumor, a myoma, was definitely encapsulated, and was readily removed through a Kraske incision

CASE IV (reported by SENN) —A woman, aged forty-five years, had been conscious of a small pelvic tumor for three years While she was being attended for a miscarriage, the tumor was felt between the rectum and the uterus It was firmly attached After two years the abdomen began to enlarge, and the patient's general health declined At the time of her examination, April 20, 1890, she was anæmic and emaciated, and her abdomen was distended with fluid After the abdomen had been tapped and the fluid removed a large tumor could be palpated in the left lower quadrant of the abdomen April 24, 1890, a laparotomy was performed, and a tumor was found attached to the anterior wall of the rectum by a pedicle at the peritoneal reflexion over the rectum It was nearly globular, weighed 12 pounds, and a cut surface showed a true fibromyoma

CASE V (reported by SENN) —A woman, aged forty-one years, was operated on through an incision in the vagina, and a fibromyoma about 3 cm in diameter was removed from the anterior rectal wall

CASE VI (reported by McCOSH) —A man, aged thirty-four years, complained of discomfort in the rectum and gradually increasing difficulty in evacuating the bowels The stools had become thin and ribbon-like, and at the time he was admitted to the hospital he had had very little bowel movement for twelve or fourteen days A hard tumor was found on the posterior wall of the rectum, extending from just above the anus to the hollow of the sacrum The mucous membrane over the tumor was smooth but adherent to the tumor, which was smooth and regular in outline The growth was thought to be malignant and a left inguinal colostomy was made Later a hard, glistening, smooth tumor, adherent to the posterior surface of the rectum, was removed through a posterior incision extending from the anus to the coccyx The enucleation was accomplished readily except at the attachment to the mucous membrane of the rectum, which was opened Six weeks later the colostomy was closed The tumor was about 10 cm in diameter and proved to be a fibromyoma

CASE VII (reported by HEURTAUX) —A woman, aged thirty-seven years, was seen August 18, 1887 She had always been in good health except for a tendency to constipation, which had been worse during the preceding three years For a month before her examination she had a constant desire to move the bowels, and for a few days there had been symptoms of obstruction, that is, abdominal distention and colic, and vomiting, at times fecal On examination a smooth ovoid tumor was palpated within the rectum The tumor had a distinct pedicle and was firm and elastic A diagnosis of myoma was made, and the tumor was removed by dividing the pedicle The obstruction was relieved The tumor weighed 90 gm and was 8 x 6 x 4.5 cm in diameter Histologic examination revealed a fibromyoma

CASE VIII (reported by HEURTAUX) —The patient, a woman, aged fifty years, was seen May 28, 1884 She had had attacks of intestinal obstruction for about ten days in 1872, and again in 1881 No further trouble occurred until May 28, 1884, when she felt severe pain in the anus and a pressing

desire to go to stool, with no result. A rectal examination was made and a hard, round tumor was found and extracted. It was nearly spherical, and measured 6 x 6.5 cm. Microscopic examination revealed a fibromyoma.

CASE IX (reported by WESTERMARK) —A woman, aged forty-nine years, had experienced occasional pain in the abdomen and sacral region, radiating down the thigh for a year and a half. She had had slight frequency and constipation. Examination disclosed a solid tumor in the right lower quadrant of the abdomen. An exploratory laparotomy revealed a soft, smooth, fluctuating tumor, about 16 cm. in diameter attached by a pedicle to the anterior rectal wall. Most of the tumor was lying to the right of the middle line. The patient died from obstruction, on the fifth day after the operation. The tumor proved to be a myoma.

CASE X (reported by RIEDINGER) —A woman, aged thirty-eight years, had had six normal deliveries and was at term at the time she was admitted to the hospital. She had been having abdominal pain for three weeks. Three abdominal tumors were palpable, and a diagnosis was made of ruptured uterus. At operation a transverse tear was found in the lower segment of the uterus and the fetus was in the peritoneal cavity. The patient died nine hours after the operation, and at necropsy an irregular fibromyoma 12 x 20 cm. was found adherent to the upper part of the rectum. It had originated in the rectal wall and was not connected with the uterus.

CASE XI (reported by LEXER) —A man, aged thirty-five years, had suffered from constipation for a long time, and had had several hemorrhages from the bowels in the course of a few weeks. Examination revealed a rectal tumor, fixed to the sacrum, just above the anal sphincter and extending higher than could be reached. The overlying mucous membrane bled easily. The tumor was enucleated with much difficulty by sacrificing the anal sphincter, which necessitated a sacral anus. A section of the tumor was reddish-gray. Microscopic examination proved it to be a true leiomyoma.

CASE XII (reported by CARLE) —A man, aged eighty-five years, complained of constipation, the sensation of a tumor in the rectum, and pain at stool. Examination revealed a tumor about 5 cm. in diameter encroaching on the rectal lumen from the posterior rectal wall 4 or 5 cm. above the sphincter. It was hard and covered by non-adherent, somewhat ulcerated mucous membrane. It was enucleated, and microscopic examination showed connective tissue with interposed groups of muscle fibres. A diagnosis of fibromyoma was made.

CASE XIII (reported by GRADENWITZ) —A woman, aged forty-one years, came for examination complaining only of lumbago. To the left and behind the uterus was a tumor 5 cm. in diameter, apparently connected with the uterus by a thin pedicle. The tumor was suggestive of a pedunculated submucous myoma of the uterus or a solid ovarian tumor. An attempt was made to extirpate the tumor through the vagina. On opening the peritoneum the entire posterior wall of the uterus was found to be intimately adherent thereto. The tumor was high in the rectum, and was enucleated after dividing the rectal mucosa. The tumor was a fibromyoma.

CASE XIV (reported by EARL) —A woman, aged forty years, was found, during labor, to have a tumor of the rectum. It was removed as the child's head approached the perineum. The tumor measured 8.7 x 6.5 x 5 cm., it had only a membranous attachment to the rectum and was readily removed. It was composed of smooth muscle fibres, with a varying amount of fibrous tissue.

CASE XV (reported by BECKER) —A woman, aged forty-four years, complained of obstinate constipation, which had been worse during the last two

MYOMA OF THE RECTUM

years Within a year she had noticed a tumor in the vagina Examination showed that the posterior wall of the vagina was pressed forward by a tumor in the rectal wall, separate from the uterus The tumor was about 8 cm in diameter and was removed through a posterior incision Microscopic examination showed it to be a myoma with very little connective tissue

CASE XVI (reported by BALL) —In this case a fibromyoma was removed from the posterior wall of the rectum The tumor, about 3 cm in diameter, was sessile, and the overlying mucous membrane was freely movable In structure it resembled a uterine fibromyoma

CASE XVII (reported by DESCOEUDRES) —A woman, aged forty-six years, came for consultation because of a bulging in the vagina which she had noticed for several years The tumor had gradually increased to about 10 or 12 cm in diameter The left buttock and the posterior surface of the thigh were enlarged The mucous membrane of the anus was drawn out to cover a portion of the tumor, which was somewhat irregular, apparently multilocular, and extended the entire length of the anterior and left wall of the rectum The tumor was enucleated by blunt dissection and found to be attached to the rectum by a pedicle It was a fibromyoma weighing 6 kg, and had undergone slight hyaline degeneration

CASE XVIII (reported by VERHOOGEN) —A man, aged fifty-five years, entered the hospital because of constipation and severe rectal hemorrhage On the anterior surface of the rectum, just behind the prostate, was a slightly movable, spherical tumor, about 10 cm in diameter and covered by smooth, non-adherent mucous membrane The tumor, which was causing entire obstruction of the rectum, was enucleated through a transverse perineal incision without injury to the rectal mucosa It proved to be a leiomyoma

CASE XIX (reported by CRIPPS) —A woman, aged forty-eight years, had suffered with slight bowel irritation for six months Examination under ether disclosed a swelling about 2.5 cm in diameter in the anterior wall of the rectum, 7.5 cm from the anal orifice This swelling was apparently in the muscular coat, the mucous membrane covering it was intact and was slightly movable over the mass At operation the rectum was split in the middle line behind, and the tumor drawn down and dissected from the muscular wall The growth was a thickened lump of the muscular coat converted into dense fibrous tissue

CASE XX (reported by FINSTERER) —A man, aged fifty years, had had difficulty in bowel movements for six years, and passage of blood for six months Examination revealed an ulcerated tumor, about 8 cm in diameter, arising from the anterior wall of the rectum The tumor was a myoma and was extirpated by removing the rectum

CASES FROM THE MAYO CLINIC

CASE XXI (A53082) —A man, aged sixty-eight years, came for examination May 16, 1911 He complained of distress and dull pain in each groin, constipation, and urinary difficulty Rectal examination showed a very hard mass, about 5 cm in diameter, on the anterior rectal wall The patient did not remain for further examination or treatment He returned to the Clinic December 30, 1916 Constipation had persisted, and recently he had noticed that the rectum did not feel empty after stool He had had acute retention of urine three times during the last three weeks, and frequency

There was moderate hypertension, the systolic blood-pressure was 160, the diastolic was 105 The patient had a double inguinal

hernia Rectal examination showed that the tumor had increased to about 10 cm in diameter It extended to the left and was outside the rectum

January 11, 1917, the tumor was removed through the perineum without opening the rectum or bladder (E S Judd) The tumor bulged into the rectum and involved the rectal mucosa, starting just above the anus The prostate could be felt above The tumor was a fibromyoma and weighed 330 gm The patient made a good recovery He returned to the Clinic February 20, 1918, stating that he had had no urinary difficulty since operation, but that constipation had recurred Rectal examination showed multiple small tumors of the anterior rectal wall These were excised March 1, 1918 The specimens showed early sarcoma and the wound was left open for radium, which was given as follows March 13, 1918, 500 mg hours, April 20, 1918, 700 mg hours, November 13, 1918, 400 mg hours, January 14, 1919, 300 mg hours, and February 4, 1919, 800 mg hours

At our last examination February, 1919, there were three nodules on the anterior rectal wall (Figs 1 and 2)

CASE XXII (A115182) —A woman, aged twenty-eight years, was first examined in the Clinic June 7, 1916, when a diagnosis was made of inflammatory disease of the pelvis She returned April 26, 1918, because of irritation in the left side of the rectum There was tenderness in both vaginal fornices and an indurated mass in the rectovaginal septum The patient was operated on June 6, 1918 (J C Masson) In exploring the rectovaginal mass it appeared to be inflammatory, but on microscopic examination of a specimen it proved to be a fibromyoma, apparently of rectal origin (Figs 3 and 4)

CASE XXIII (A295358) —A man, aged fifty-nine years, was examined November 3, 1919 He complained of difficulty at defecation for the last six or seven months, and a feeling of obstruction in the rectum There had been no bleeding nor diarrhoea The systolic blood-pressure was 100, diastolic was 70 The temperature and pulse were normal The urinalysis, the roentgenograms of the kidneys and bladder, the cystoscopic examination, and the blood Wassermann reaction were negative The phenolsulphonephthalein output was normal

The patient was sent in for operation (W J Mayo) November 18, 1919, with a diagnosis of rectal tumor, probably myoma Exposure was obtained through a posterior incision with removal of the coccyx and terminal portion of the fifth rectal vertebra The growth was posterior to the rectum, extending laterally toward the bladder and inside the true rectal fascia, evidently beginning in the non-striated tissues of the rectum, it was removed with the capsule, which was closely attached to the rectum The tumor measured 9 x 6 x 6 cm and examination showed cellular myoma

The patient made a good recovery and was dismissed from the hospital on the tenth day, and from the Clinic on the twenty-fifth day after the operation (Figs 5 and 6)



FIG 1 (Case A53082) —Photomicrograph of fibromyoma of the rectum $\times 50$

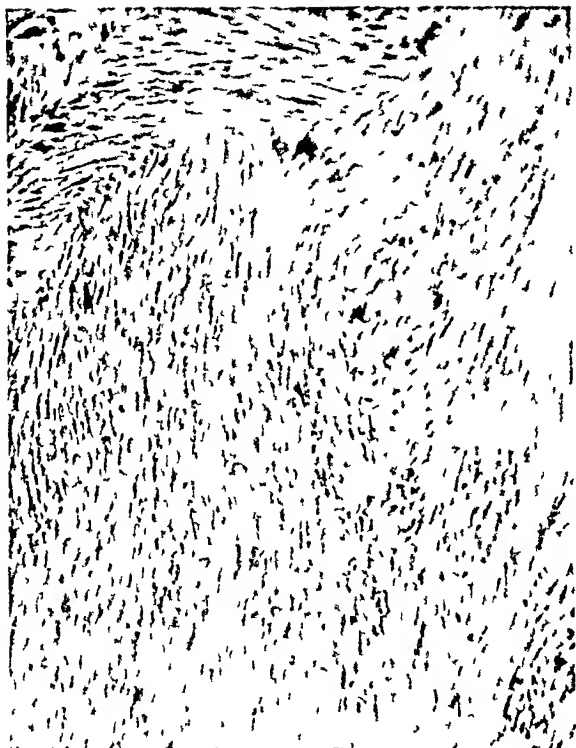


FIG 2 (Case A53082) —Photomicrograph of fibromyoma of the rectum $\times 100$



FIG 3 (Case A115182) —Photomicrograph of fibromyoma of the rectum $\times 50$



FIG 4 (Case A115182) —Photomicrograph of fibromyoma of the rectum $\times 100$



FIG 5 (Case A295358) —Photomicrograph of myoma of the rectum $\times 50$

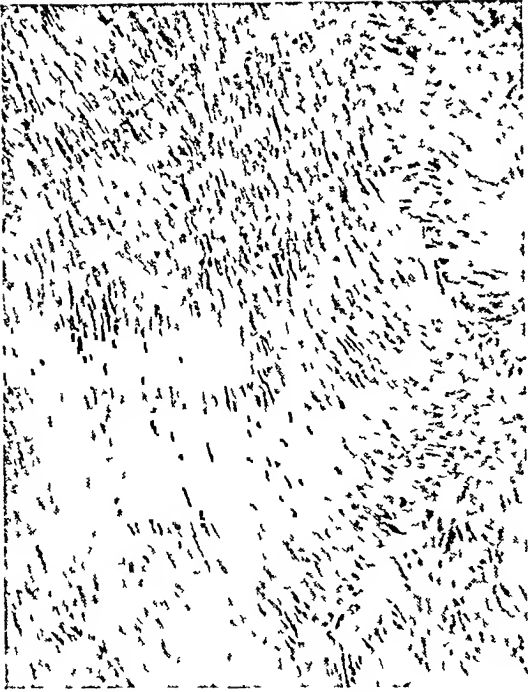


FIG 6 (Case A295358) —Photomicrograph of myoma of the rectum $\times 100$



FIG 7 (Case A308866) —Photomicrograph of myoma of the rectum $\times 50$

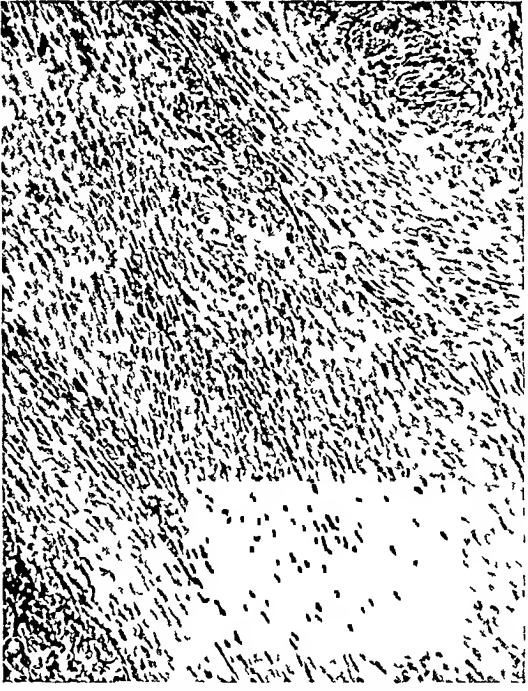


FIG 8 (Case A308866) —Photomicrograph of myoma of the rectum $\times 100$

CASE XXIV (308866) —A man, aged thirty-four years, had had three operations on the rectum elsewhere for tumor believed to be cancer. The last operation was performed January 15, 1920. He presented himself at the Clinic March 18, 1920, with the following history. In 1915 he first noticed difficulty in moving his bowels, this condition grew progressively worse and was associated with some pain. In 1916 he had an operation for hemorrhoids, with relief for one year. A diagnosis of cancer was then made and a second operation performed, followed by improvement for two years, when the symptoms recurred. Two operations were performed in January, 1920, procedures not stated. Blood had been noted in the stools at various times. The patient had not lost weight, and his general health was good.

At the time of examination the patient weighed 175 pounds, he was very pale. The systolic blood-pressure was 126, the diastolic was 78. There was a slight systolic murmur at the apex. About 2.5 cm. above the anal sphincter was an excavated mass involving chiefly the left rectal wall and extending up into the rectum about 10 cm. The mass was ulcerated and bled readily and extended into the perirectal tissues. The mucous membrane over the growth was smooth and not infiltrated. The tumor was thought to be non-malignant and inflammatory.

Operation was performed March 20, 1920 (V. C. Hunt). The anal sphincters were divided posteriorly, and a specimen of the growth removed for microscopic examination. The tumor, which proved to be a myoma, was entirely removed by enucleation and the cavity packed with iodoform gauze. The patient made a satisfactory convalescence. Radium was given rectally as follows: March 29, 1920, 560 mg. hours, April 2, 1920, 1160 mg. hours, April 5, 1920, 1762 mg. hours, a total of 3482 mg. hours. The patient was allowed to go home, but was advised to return in three months. July 6, 1920, the rectal mucous membrane was smooth, and there was no evidence of recurrence. The sphincters were somewhat weak, resulting in partial incontinence. The hæmoglobin was 44 per cent. Recent letters from the patient and from his local physician state that there is no recurrence. The patient is to return to have the sphincter muscles repaired (Figs 7 and 8).

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TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting Held March 23, 1921

The President, DR. WILLIAM A. DOWNES, in the Chair

ACUTE HÆMATOGENOUS OSTEOMYELITIS

DR. F. W. BANCROFT read a paper with the above title, for which see page 681, June, 1921, lxxiii. He presented lantern slides and two children in connection with the paper.

SUB-TOTAL GASTRECTOMY FOR EXTENSIVE TUBERCULOSIS OF THE STOMACH

DR. EDWIN BEER presented a young colored man, twenty-one years of age, who was admitted to the service of Doctor Abbott, at Bellevue Hospital, on November 3, 1920. His chief complaint was vomiting for a period of three months. He had lost in last three months twenty-three pounds. He had had no previous diseases, but five years prior to admission he had a sore on the penis which lasted two to three weeks and was complicated with suppurative bubo. No secondaries developed and blood examination made three months before admission was negative. Wassermann was ante-complementary. His present trouble had begun two years ago with attacks of pain in the epigastrium. These attacks have become much more frequent during the last three months. Now he is troubled with vomiting every day, which comes a few minutes to several hours after eating, and often vomits food taken on the previous day. At present, no nausea or pain, never vomited blood, bowel normal. No jaundice and no urinary symptoms. Physical examination showed an emaciated, underfed young man. The examination of the chest showed râles and impairment of breathing at both apices. Abdominal examination showed distinct enlargement of the stomach with large and visible peristaltic waves which passed from left to right towards the pylorus. X-ray examination of the stomach showed marked stenosis of the pylorus with dilatation of the stomach. Sputum examination was negative for tubercle bacillus. X-ray examination of the chest showed no evidence of tuberculosis. The patient was transferred to the surgical side. It was suggested that he be given gas-oxygen on account of his possible pulmonary involvement, in spite of the negative X-ray findings and sputum. On November 15, 1920, operation by Doctor Beer. Right upper rectus incision exposing the stomach, at the pyloric end and involving the antrum there was a large tumefaction about the size of an adult palm with many dozens of enlarged glands along the lesser curvature and along the greater curvature. The mass in the stomach was freely movable.

and very firm, and gave the impression of being a malignant growth. A wide rapid excision of the involved area and the enlarged glands was made with the cautery technique. The duodenal stump was inverted and covered with the pancreas. The cardiac stump was closed with several layers of sutures after dropping the male half of a Murphy button into this end of the stomach. Then an ante-colonic, long loop, anterior gastro-jejunostomy with Murphy button was done, using the half of the button that had been dropped into the stomach for the anastomosis. Patient made an uneventful recovery and was discharged from the hospital November 27, 1920, with the Murphy button still in place. The report of the pathologist, Doctor Symmers, upon the mass removed is

Specimen consists of a mass removed from the stomach. The mass measures about 10 cm in length and 16 cm in breadth. For purposes of description, it is divisible into two portions—an upper, which consists of gastric mucous membrane thrown into large folds, and a lower, in which the walls of the stomach are thickened to the extent of from 1 to 1½ cm. On section the cut surface of the stomach wall in this locality is perfectly smooth, firm and dead white. It is surrounded on the inside by mucous membrane which is thrown into numerous large folds, and from which numbers of small teat-like polypi project. The mucosa covering the lower few cm of the stomach is superficially eroded.

Microscopic examination of the lower portion of the stomach, corresponding to the thickened walls described above, shows the presence of superficial erosion of the epithelial tubules. The most striking feature in the histologic picture, however, consists in extensive round-cell infiltration, the infiltrating cells consisting partly of lymphocytes and partly of plasma cells. Scattered through the deeper portions of the stomach wall are numbers of typical epithelioid tubercles.

The specimen is accompanied by many enlarged lymph nodes. One of these, on microscopic examination, shows many epithelioid tubercles.

Diagnosis. Hyperplastic tuberculosis of pyloric region of stomach, tuberculosis of perigastric lymph nodes.

DR WM A DOWNES recalled that several years ago Doctor LeWald and he had reported several cases of syphilis of the stomach, which clinically were proven cases of syphilis of the stomach. He removed a specimen from one case and sent it to Doctor Wood for examination. Doctor Wood would not commit himself absolutely, but he described the pathology in detail, and stated that while there was resemblance of tuberculosis he felt that the condition was syphilis rather than tuberculosis. Indeed, frequently it was difficult to distinguish between tuberculosis and syphilis of the stomach. In these cases in which Doctor Wood would not commit himself gastroenterostomy was performed and antisyphilitic treatment instituted and they had remained well. If it had been a tuberculous condition it seems that it would have been progressive, though possibly it might have become latent. At any rate all of these patients had gained in weight, and one had given birth to a baby.

Doctor Beer said he had no idea at the time of operation that it might be tuberculosis, but thought that it would be carcinoma or lymphosarcoma. If he had thought of the possibility of its being tuberculosis he would have prevented the specimen being damaged by formalin. That was unfortunate because formalin hardened the specimen so that it was difficult to find the tubercle bacilli.



FIG 1 —Tuberculous ulcer of stomach Sketch showing position of enormous tuberculous ulcer with almost smooth surface which involved the whole antrum anterior and posterior walls beginning close to the pylorus and extending well up into the body of the stomach with innumerable glands in the lesser and greater curvatures removed by sub total gastrectomy

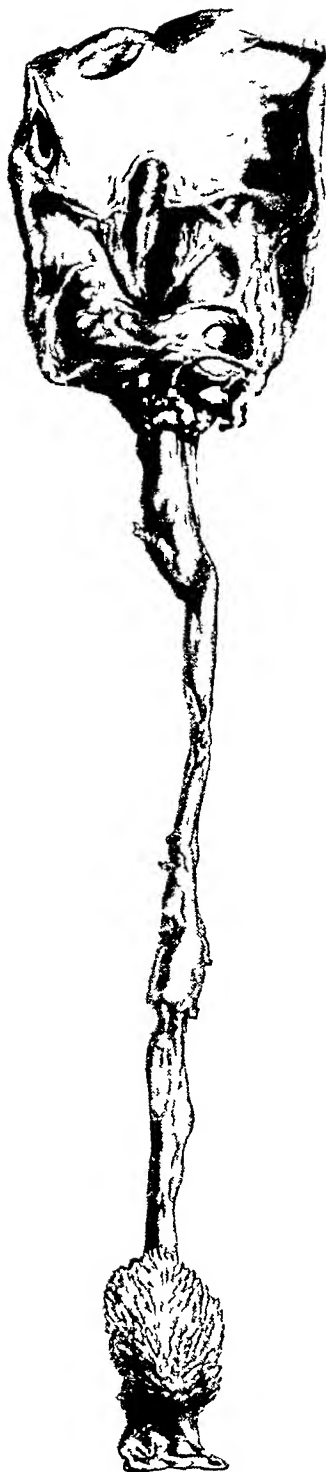


FIG 2 —Sketch of hydro nephrotic kidney and hydro-ureter exposing at the lower end of the ureter which has been opened a primary benign papilloma 7 cm from bladder. Specimen removed at operation by aseptic nephro ureterectomy without opening the upper urinary tract

ASEPTIC NEPHRO-URETERECTOMY

ASEPTIC NEPHRO-URETERECTOMY FOR PRIMARY PAPILLOMA OF THE URETER

DR EDWIN BEER presented a man, sixty-one years old, first seen February 4, 1920, for hæmaturia. He had had four attacks, the first twelve months ago, and then every three to four months thereafter. No pain accompanied bleeding. The blood was bright red and clotted. There was no obstruction to outflow from the bladder, frequency was practically normal, at night one urination. Past history of ulcer of the stomach and chronic bronchitis and emphysema. No recent loss of weight.

February 4, 1920. Cystoscopy performed while not bleeding showed the following:

Stricture of the deep urethra, which bled on stretching. intra-urethral and vesical adenoma formation of prostate which bled readily, fair-sized diverticulum in anterior bladder wall whose interior could not be completely inspected (hidden tumor), good indigo output from left kidney, none seen coming from the right, specimen from left full of blood-cells, probably traumatic, no obstruction on this side, obstruction on right side at 8 cm. and no specimen obtained. After withdrawal of the catheter from the right ureter there was a continuous flow of blood from this side. Palpation suggested enlarged right kidney.

D. D. Stone in right ureter, tuberculous stricture, tumor of the ureter. X-ray was negative for stone and no TBC could be recovered. To determine accurately the source of hæmaturia the patient was instructed to return during attack. After several attacks he came in with his bladder full of clots which he could not express. After emptying his bladder October 18, 1920, it was evident that the blood came from the right ureter which was obstructed at 7 cm. On the strength of these findings the diagnosis of tumor of the right ureter was probable, and the possibility of the original growth being in the pelvis was considered as likely. Therefore a nephro-ureterectomy without opening the urinary channels was advised. Owing to the patient's poor general condition there was some hesitation as to the advisability of going ahead. Finally, however, the operation was decided upon not only to get rid of the source of bleeding, but to obviate the possibility of being forced to do a palliative cystostomy to empty his bladder of clots which he had been unable to void because of his considerably enlarged prostate.

December 1, 1920. Under gas-oxygen the kidney was exposed and found to be markedly hydronephrotic with dilated ureter. The vascular pedicle was tied and the large ureter was freed well down across the pelvic brim, a silk ligature applied to same for purpose of identification, then the patient was rolled partly on his back and the pelvic ureter was exposed through a paræctus extraperitoneal incision and ligated well below the tumor which could be distinctly felt in the lower ureter. At the site of the growth the ureter was firmly adherent to the pelvic wall. After doubly ligating the ureter near the bladder, it was cut between and by traction on the silk ligature placed on the ureter through the lumbar wound, the whole ureter and hydronephrotic kidney were withdrawn in

one piece and unopened The patient made a rapid convalescence

The specimen showed a fair sized hydronephrosis and hydro-ureter with a papillary growth near the lower end The microscopic report by Doctor Mandelbaum stated that the growth was benign

SUBCUTANEOUS RUPTURE OF THE SPLEEN

DR JOHN F CONNORS read a paper with the above title and presented two patients in illustration of the subject

DR JAS M HITZROT said it was a curious fact that when the profession knew but little about any given organ that the theories regarding the effect of its removal were apt to be quite numerous The splenectomized individual was stated to be prone to infection, less resistant to hemorrhage, more subject to new growths, even less amiable in disposition, yet there was a complete failure to demonstrate any of these factors as having occurred in the human individual who had lost a normal spleen The Society would perhaps recollect that Doctor Downes presented a case of spontaneous rupture of the spleen in the third week of typhoid fever, in which the patient made a normal recovery from typhoid The patient also recovered from a cellulitis of the cheek, a peritonsillar abscess, and from the extraction of a tooth in what could easily be said to be a normal interval

Doctor Hitzrot said he did not believe that it had been demonstrated that the function of the spleen was not rapidly compensated for by other organs and that within a very short interval following the splenectomy If the spleen acted as a storehouse for antibodies formed after an infection, it would seem that these antibodies were rapidly stored elsewhere after splenectomy Pearce and his collaborators were of the opinion that the splenectomized individual suffered more severely from hemorrhage and recovered more slowly from the effects of hemorrhage than the normal individual, but other than that Doctor Hitzrot believed that little else occurred

The question of partial splenectomy, tamponade, etc, deserved no discussion, as it was much easier to remove a spleen than to resect it, and much safer to remove it than to depend upon packing or upon suture to control the hemorrhage

As to the question of the hypertrophy of the hemolymph glands or accessory spleens it was yet to be proven that this process occurred In one of Doctor Hitzrot's patients, submitted to a second operation for a lower abdominal lesion in which a previous splenectomy had been done and in which these small reddish bodies had been noted along the splenic vein, palpation of the area of the vein at the second operation did not demonstrate any enlargement of these structures While Doctor Hitzrot could not actually see them, they did not feel increased in size

For evidence of the importance of the spleen in the infections the recent work of Morris and Bullock (ANNALS OF SURGERY, vol xxxvii, page 513, et seq) should be consulted Their conclusions, at least for rats, differ from that observed by Doctor Hitzrot for the human individual, and the operative

SUBCUTANEOUS RUPTURE OF THE SPLEEN

wound produced to remove the spleen healed as kindly as any other wound of similar character, even in the anæmic individuals so frequently submitted to the operation of splenectomy

DR EDWIN BEER said that, though the spleen was usually more easily removed than resected, occasionally it was possible to save injured organs by using a technic that had been very useful in kidney operations. In operating upon the kidney, liver or spleen, the stitches often did not hold well and were liable to cut in, thus not controlling hemorrhage. To prevent sutures cutting into these viscera he has used underpinning with fair-sized pieces of fat, usually taken from the wound. The double-threaded straight needle pierced the organ, and as the knots were tied at the entrance and exit of suture they were tied over a piece of fat. In this way the vascular tissue could be compressed between the wads of fat without the thread cutting into the tissue.

DR ROBERT T MORRIS called attention to a point in the technique in cases in which there was a large amount of blood in the peritoneal cavity. This blood was still in the circulation in a way because it was in the large lymph chamber. When one opened the peritoneal cavity the patient sometimes bled to death because of the turning out of a large amount of blood. Clots only should be removed. The opening of the peritoneal cavity introduced a critical moment and one could carry the patient over this time of danger by having saline solution at hand and the needle already in the vein in the arm, the infusion of saline should begin at the very moment of opening the peritoneal cavity.

Doctor Morris said he had used decalcified bone in the same way as Doctor Beer described using the fat pads in operating upon both the liver and the spleen. Decalcified bone gave a broad firm support for the through and through sutures.

DR FRANK S MATHEWS said there was an impression that bleeding into the peritoneal cavity was a total loss of blood to the patient. Doctor Sweet, of Philadelphia, had performed the experiment of putting blood into the peritoneal cavity of animals and in a short time found the red cells in the thoracic duct. It is a waste of time to remove all the blood from the peritoneal cavity. One may remove the clots and leave the fluid blood, and in a short time the red cells will be returned to the circulation. Of course, if infection is present, there will be an additional reason for removing the blood.

DR THEODORE DUNHAM remembered that a peculiarity of Dichloramine-T is that when it is not pure the impurities are generally of such a nature that they are particularly harmful. Free hydrochloric acid and free chlorine are apt to be given off. When present in any considerable amounts, these emanations are very damaging to the living tissues, sometimes more harmful than the germs we are trying to destroy. Fortunately, these impurities are revealed by a pungent smell. Pure Dichloramine-T has a very mild chlorous odor, which is neither disagreeable nor repellent. As these impurities are very volatile, a bottle of inferior Dichloramine-T may have a pungent odor when freshly opened, from an accumulation of these gases, but lose most of its

pungency after it has been opened or the cork left loose for a time. Such a sample had better not be used. One is safe if the substance is in the form of clean crystals and the freshly opened bottle gives forth only a very mild chlorous odor.

The quality of the Chlorcosane is also of great importance. Some samples have a more viscous element suspended in them or clinging to the inner surfaces of the bottle. Such samples are, I think, not properly chlorinated and are liable to take chlorine from the Dichloramine-T and so decompose it. A really good Chlorcosane is a practically clear and homogeneous fluid and only such, I think, should be used.

In making up the solution of Dichloramine-T it should not be forgotten that water decomposes it. It is best thoroughly to dry by heat the vessel in which the Chlorcosane is measured, in which the Dichloramine-T is weighed and dissolved, and the bottles in which the solution is kept. Sunlight and electric light decompose Dichloramine-T. The more impure the ingredients, the more quickly will light decompose the solution.

A solution made carefully from good materials and shielded from light will keep clear and good for months.

He had used Dichloramine-T in a great variety of wounds. A 5 per cent solution is particularly useful in situations where it is important to have an antiseptic travel along a very tenuous channel and there maintain an antiseptic power. In cases of infection at the side of the finger nail or toe nail this oily solution will often find its way down a crack and sterilize the infected region without painful procedures. So, too, where the proximal part of the nail is removed to reach an infected area, or where this end of the nail can be lifted up, the oily fluid will insinuate itself and often do excellent work without any smarting. Where a splinter has run far under the nail and broken off, he had shaved away enough of the nail to grasp and withdraw the splinter and then applied the oil. He could look through the nail and see the oil run by capillary action and fill up the space from which the splinter had been withdrawn, and thus with no attendant pain or future incident. In a recent and inflamed puncture wound of the hand with a tract about an inch in length, he worked the oil along the length of the tract with a silkworm-gut drain. The swelling and other signs of inflammation subsided without any cutting being necessary.

For many purposes Dichloramine-T is of course not as good as other antiseptics, but for certain situations it has no equal. What he most particularly wished to emphasize was the importance of using a pure solution.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting held April 4, 1921

The President, DR GEORGE G ROSS, in the Chair

FRACTURE OF THE METATARSAL BONES

DR EMORY G ALEXANDER read a paper with the above title, for which see page 214.

DR ARTHUR B GILL remarked that it is essential after fractures of the metatarsals to support them on the plantar side by some form of arch support. For this purpose he used hard felt pads. It is rather remarkable what little disability patients have, who have suffered from more or less severe fractures of the bones of the foot, if care has been taken during the treatment to preserve the proper arch of the foot and to prevent pes valgus or pes varus. Accurate re-position of fragments of the tarsus and metatarsus seems to be unnecessary if the proper position of the foot is maintained with reference to weight-bearing.

From the operative procedures which are done upon paralytic feet surgeons have become familiar with the resistance of the foot to severe operative traumatism. In subastragalar arthrodesis and in horizontal transverse section of the foot a large amount of traumatism is inflicted upon the bones and even upon the soft parts without subsequent infection or necrosis and sloughing. The considerations in treatment of the foot are the preservation of the normal arch and the maintenance of the foot in such position that the weight-bearing line which comes down along the crest of the tibia should fall centrally in the foot.

When the fracture of the metatarsals is very close to the head so that a small fragment of bone is displaced laterally or to the plantar aspect, it is better to excise this fragment. This Dr Alexander did in one of his cases. Such excision can probably best be done through a circular incision on the plantar surface of the foot just back of the toes.

RUPTURE OF UTERUS DURING ATTEMPTS AT VERSION

DR ASTLEY P C ASHHURST reported the case of a woman, forty-one years of age, who was admitted to the Abington Hospital on December 28, 1920, with the diagnosis of ruptured uterus.

The woman had given birth to nine children, all at term. These births

were all normal with normal puerperal period Her tenth labor began December 26, 1920 Having not been able to deliver herself by the following day she summoned her family physician, who finding a shoulder presentation, attempted a version, but without success Another physician was called in consultation, and under nitrous oxide analgesia, version was twice again attempted At the end of the second attempt the patient suddenly went into collapse

One hour later Dr Ashhurst saw the patient and noted the following Expression anxious, air hunger with no abdominal breathing, skin moist and cool, pulse very rapid and thready, abdomen distended and tender to touch There was a large irregular mass in the epigastrium which could be recognized as a foetus The uterus could be readily palpated, and found well contracted, with the fundus a hand's breadth above the symphysis

Under nitrous oxide anæsthesia the abdomen was opened by a right paramedian incision 15 cm in length A large quantity of blood was evacuated The uterus was delivered, and grasped just above the cervix to prevent further bleeding A rupture 9 cm long was found in its mid-line on the posterior wall The foetus and placenta were found free in the epigastrium and removed Clamps were applied to the broad ligaments, and a subtotal hysterectomy was done The stump was closed with continuous chromic gut sutures, uterine vessels ligated, edges of broad ligaments brought together by a continuous sero-serous suture of chromic gut, stump covered with peritoneum in same manner, abdominal cavity flushed with normal saline, cigarette drain carried down to stump of cervix, abdomen closed in layers

With the maximum amount of stimulation, repeated hypodermoclysis, continuous enteroclysis, and with all due credit to her natural resistance, she began to improve after the first twenty-four hours From this time on convalescence was uninterrupted, and she was discharged as cured thirty days after operation

Histologic examination of the uterus showed an occasional ruptured muscle fibre with a mononuclear infiltration

DOUBLE AMPUTATION OF THE THIGH FOR SENILE GANGRENE

DR ASTLEY P C ASHHURST presented a man seventy-two years of age, who was admitted to the Episcopal Hospital October 3, 1920, with a diagnosis of gangrene of left foot

Patient stated that two weeks ago he began to have a burning pain with tingling from toes to knee on left A day or so later he noticed that his toes on that side were reddened This color soon changed to a purple, and at the same time the pain disappeared Examination showed the foot and toes cold and purple in color Slight pitting on pressure No pulsation could be felt over the popliteal, dorsalis pedis, or posterior tibial arteries There was swelling, pain, and beginning redness of the toes of the right foot, with absence of arterial pulsation

On October 8, 1920, the left thigh was amputated in the lower third On

AUTOTRANSFUSION

examining the stump it was found that the femoral artery was thrombosed. When the tourniquet was removed there was little or no bleeding from collaterals. The femoral artery was then dissected up to a point where pulsation was found, and the ligation made at this point. The smaller vessels were ligated, sciatic nerve drawn down and cut, rubber tube drainage instituted, and the skin flaps loosely brought together with interrupted silkworm sutures. Patient returned to bed with stump elevated and heat applied.

On October 22, 1920, Dr Ashhurst amputated the right thigh in the lower third. Again femoral artery was found thrombosed, and only slight oozing from collaterals. Muscles closed over stump with mattress sutures of chromic gut. Skin closed transversely with interrupted silkworm sutures. Rubber tube drain at outer angle of wound.

For several weeks following the operation the patient was irrational. During this time he repeatedly removed his dressings which resulted in a superficial infection of both stumps. This cleared up, and he went on to a complete recovery.

Laboratory findings: Wassermann negative. Urine negative. Histologic examination of specimens showed marked arteriosclerosis.

AUTOTRANSFUSION

DR FRANCIS C GRANT presented a man forty-two years of age, who was admitted to the service of Dr C H Frazier at the University Hospital, presenting a clear-cut picture of cerebellar tumor. A suboccipital exploration was determined upon. It had been their routine practice of late to transfuse postoperatively all cases upon whom a suboccipital exploration has been performed. The procedure is of necessity a prolonged one accompanied by considerable shock to vital centres, and they had found that immediate transfusion insured a prompt reaction and improved the postoperative course. The patient in question had no money to pay for a donor and was of type 3, the least frequent type. They had no donors of this type on their free list. However the patient was large, stout, and plethoric. His B C R totalled, 6850,000 with 110 per cent Hgb confirmed by several counts. Robertson, Rous and Turner, and others had shown that whole blood could be kept citrated and cold for a considerable time. From observation upon six donors they knew that following the withdrawal of 500 c c of blood the cell count and hæmoglobin returned to normal in five to nine days.

The patient was definitely plethoric, his blood pressure was 155 systolic and 110 diastolic. In view of the fact that they could not obtain a suitable donor and that transfusion would be desirable following his operation, it was suggested that they bleed the patient, allow him twenty-four hours to recover from the transfusion, operate upon him, and transfuse him with his own blood. This was accordingly done. The blood was obtained, kept in 2 per cent sodium citrate solution in a refrigerator and retransfused following operation. Three hours after operation the temperature, pulse, and respiration were 100, 118, and 18, the highest point reached. Clinically no reaction was

noted The postoperative course was favorable Four days after operation the R B C were 4,919,000, Hgb 90 per cent and blood pressure 135-100

In conclusion, they suggest that although the plethora and high blood pressure seemed special indications in this case, autotransfusion might be considered in other conditions In cases where a donor cannot be obtained for any reason and in which a patient with a high normal blood picture faces an operation known to be attended with shock and hemorrhage, if he be bled sufficiently far enough in advance of his operation to allow his blood picture to return to normal, this blood may be kept with safety and retransfused at a time when such a procedure may be life-saving

AMOEBIIC ABSCESS OF THE LIVER

DR ADRIAN W VOEGELIN read the history of a case of abscess of the liver to illustrate the importance of early recognition and operation of such cases

C G, a male, aged thirty-five, was admitted to the Episcopal Hospital on January 3, 1921, complaining of pain and swelling in the right upper abdomen He remembered having been ill seventeen years ago with a persistent diarrhoea No other history of dysentery could be obtained One year before admission he had been in another hospital where an abscess of the liver was incised Culture of the pus was negative and the nature of the abscess was not determined Three months before the present admission he began to suffer pain in the region of the old scar, and developed a gradually increasing swelling The patient was extremely emaciated No jaundice was present In the upper right abdomen, just below the ribs, was a rounded swelling quite tender and tense on palpation and evidently containing fluid The skin was slightly reddened and a small scar about two inches long was to be seen The edge of the liver could not be felt Further examination of the abdomen was negative Temperature, 98°, pulse, 92, respirations, 22 The blood examination showed Hæmoglobin, 70 per cent, erythrocytes, 3,870,000, and leucocytes, 20,200, of which 83 per cent were polymorphonuclear, 8 per cent mononuclear, 8 per cent lymphocytic, and 1 per cent transitional cells No amoebæ could be found in the stools

On the day after admission, the patient was operated upon under gas anæsthesia by Dr E G Alexander A right rectus incision about four inches long was made, opening the peritoneal cavity, which contained a little sterile serous fluid A swelling about the size of a fist, projecting anteriorly, was found on the surface of the liver As but few adhesions were present, the opening of the abscess was postponed, and, after walling off the peritoneal cavity with gauze packing, moist dressings were applied to the open wound Forty-eight hours later, an abscess cavity, about five and one-half inches in diameter and occupying most of the right lobe of the liver, was opened with a cautery knife, and evacuated of over three pints of viscid brownish fluid which contained much fine granular detritus, a trace of bile and few pus cells, and gave no growth on several culture media A large rubber-tube drain was inserted and gauze packing and dressings applied The patient's

PERFORATED GASTRIC AND DUODENAL ULCER

temperature rose to 103° , but gradually came down to normal within a week without any signs of peritonitis having developed. Curettings taken from the abscess wall two days after evacuation showed many motile amoebæ on the warm microscope stage. The pus which drained away gradually became thinner, and ceased shortly after the first week, when daily irrigation of the cavity with eusol solution was begun in order to stimulate granulations and destroy the amoebæ. Eusol is a watery chlorine preparation, the active principle of which is hypochlorous acid, which was first used for amoebic abscess by Love in 1918 among the British troops in Mesopotamia.

Under this treatment, combined with emetine, repeated scrapings from the walls of the abscess were negative for amoebæ, and the cavity rapidly contracted in size. The general condition of the patient slowly improved for about two weeks, but he then gradually succumbed to exhaustion and uræmia and died twenty-two days after operation. No post-mortem examination could be obtained. At no time had the fæces shown amoebæ. The abscess which this patient had was the result of a latent amoebiasis of apparently many years' duration.

PERFORATED GASTRIC AND DUODENAL ULCER WITHOUT PREVIOUS PAIN

DR GEORGE P. MULLER read a paper with the above title, for which see page 223.

CORRESPONDENCE

DISLOCATIONS OF THE SEMILUNAR CARPAL BONE

EDITOR OF ANNALS OF SURGERY

SIR In my article on Dislocations of the Semilunar Carpal Bone, published in the ANNALS OF SURGERY, May, 1921, pages 621-28, I note that an error is found on page 628. The sentence should read "Removal of the semilunar causes *no* interference with good function at the wrist." The sentence as it appears in the Journal reads as follows "Removal of the semilunar causes *an* interference with good function at the wrist."

You will readily see that the published statement is contrary to the impression that I was anxious to convey.

Respectfully yours

ISIDORE COHN

BOOK REVIEWS

INJURIES AND DISEASES OF THE BONES AND JOINTS Their Differential Diagnosis by Means of the Rontgen Rays By **FREDERIC H BAETJER, M D**, and **CHARLES A WATERS, M D** New York, 8vo 394 pages Paul B Hoeber, 1921

This book, from the standpoint of the rontgenogram, concerns itself with the differential diagnosis of injuries and diseases of the bones and joints. The literature on this vast and important phase of medicine and surgery—literature that is easily understood, readily comprehended, and pleasant to read—is, indeed, scarce. True, there are numerous books on rontgenology, the majority of which, however, are so highly technical, or whose contents are devoted so largely to the actual technic of rontgenology, or in which the clinical aspect of the case, as the doctor sees it in his office, is neglected, that they are of but little value to the clinician. Such, indeed, is not the case with the book under review. In its preparation, it is very evident that the authors were in close and constant touch with the operating surgeons at the Johns Hopkins Hospital.

In the text, one reads the main clinical points in the diagnosis. In the accompanying plates, of which there are 332, one sees illustrated, the differential points under discussion. The entire subject is presented thoroughly, systematically, and completely. To be brief, the authors consider normal bones, epiphyses, fractures, dislocations, bone infections, joint lesions, bone tumors, abnormalities, dystrophies, and present a separate chapter on the spine.

The reviewer predicts, for this book, a wide range and a useful future.

MERRILL N FOOTE

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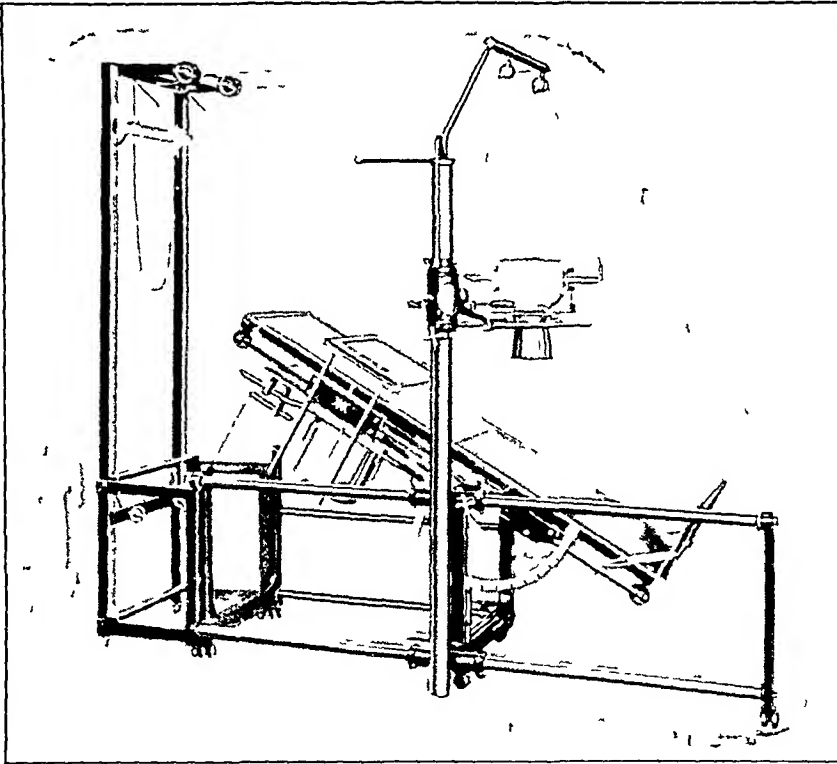
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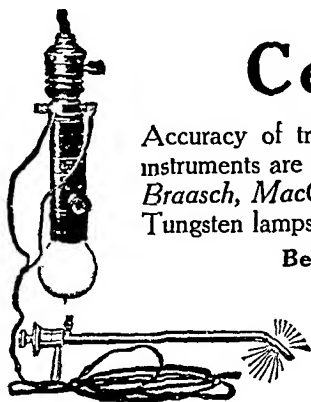
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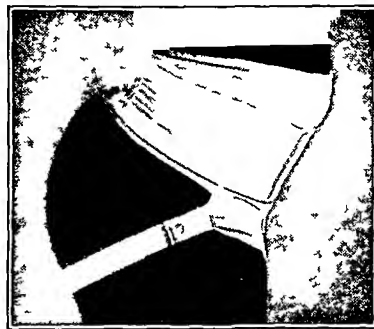


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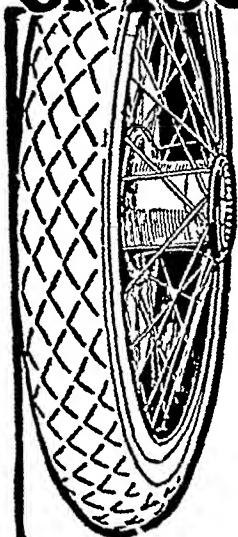


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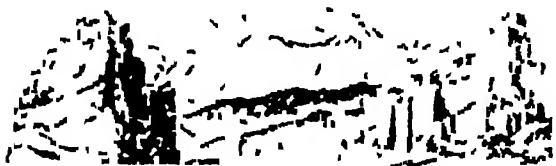
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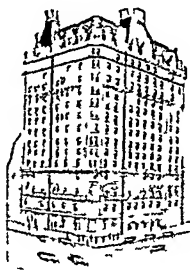
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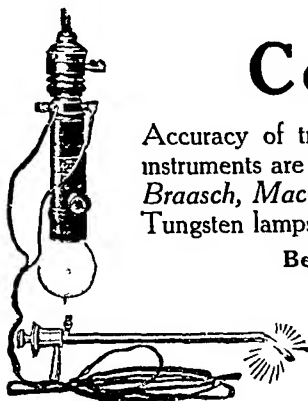
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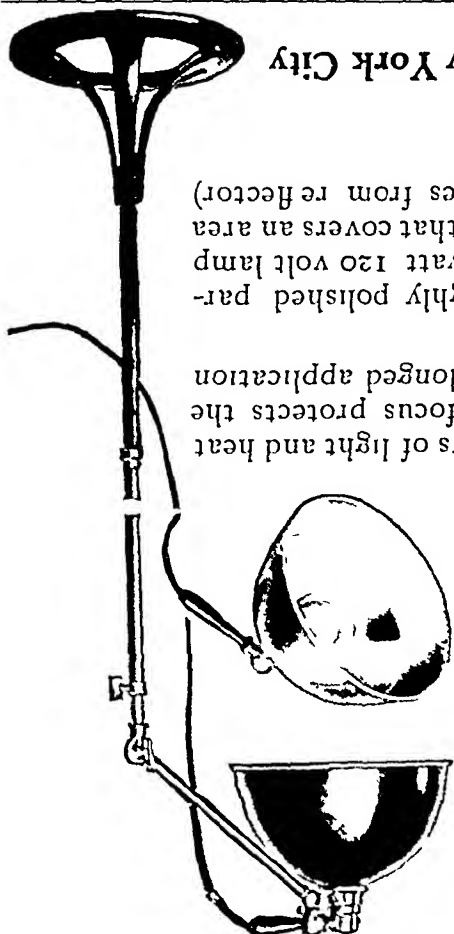
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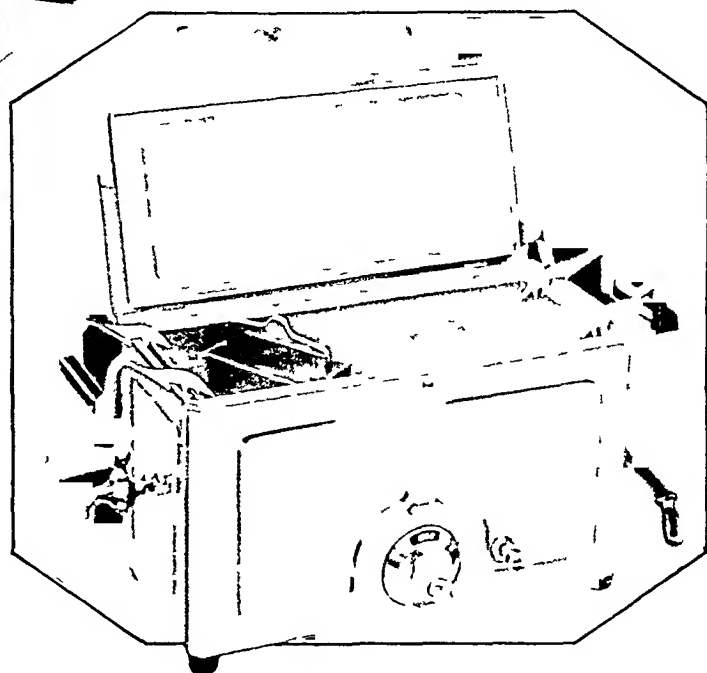
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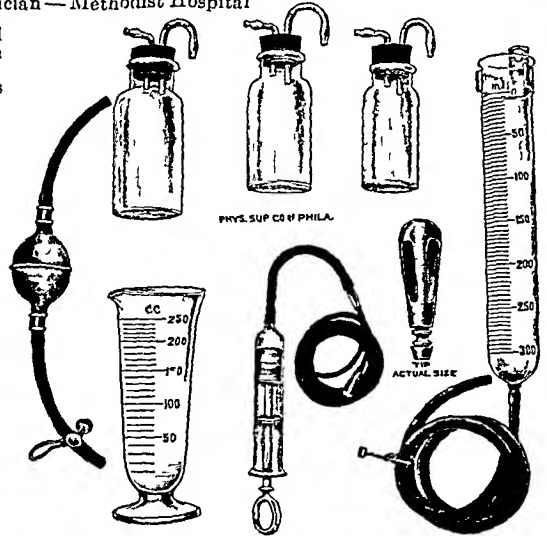
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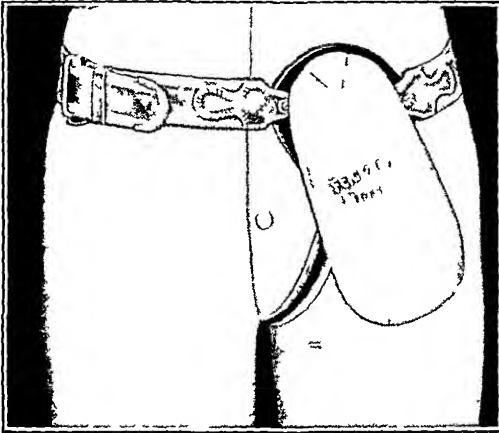


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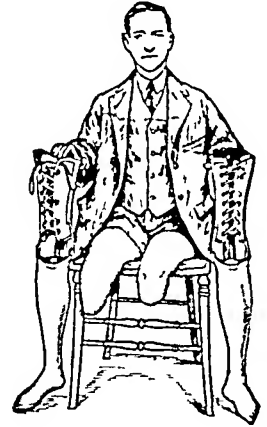
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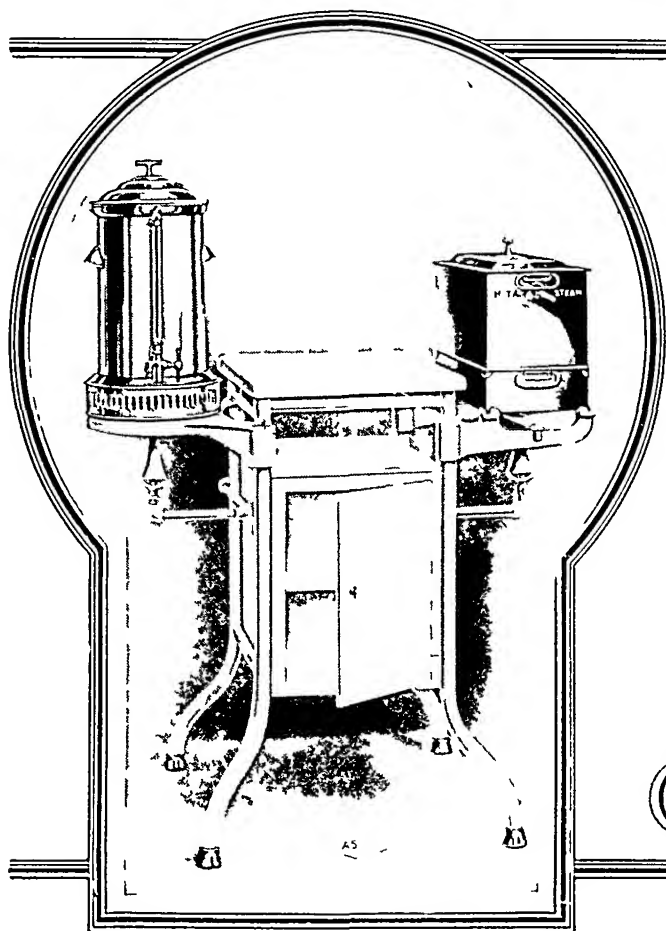
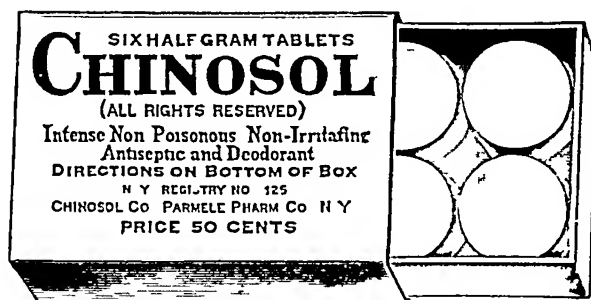
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The Surgeon-General's Opinion of the Carrel-Dakin Treatment

MERRILTE W IRELAND,
M M D, Surgeon-General of
the United States Army, sum-
marized in a recent issue of the
Journal of the American Medical
Association, the achievements of
the Army Medical Departments
in the World War

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wound treatment during the early
stages of the war, General Ire-
land continued

"Out of all this controversy
and welter of opinions, there was
at last evolved one of the great
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the application of wound treat-
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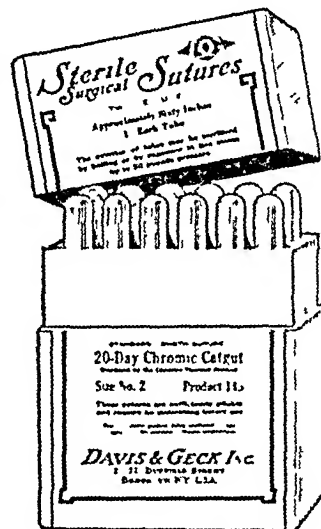
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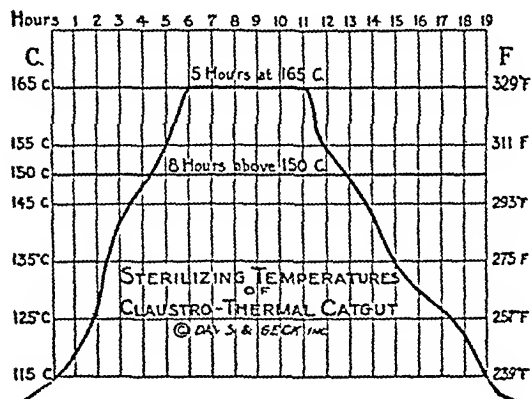
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0	_____
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360	Horsehair	Four 28-Inch Sutures	00
390	Plain Silkworm Gut	Four 14-Inch Sutures	00, 0, 1
400	Black Silkworm Gut	Four 14-Inch Sutures	00, 0, 1
450	White Twisted Silk	60 Inches	000, 00, 0, 1, 2, 3
460	Black Twisted Silk	60 Inches	000, 0, 2
480	White Braided Silk	60 Inches	00, 0, 2, 4
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812	10-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
822	20-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
862	Horsehair	Two 28-Inch Sutures	00
872	Plain Silkworm Gut	Two 14-Inch Sutures	0
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914	10-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
924	20-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
964	Horsehair	Two 28-Inch Sutures	00
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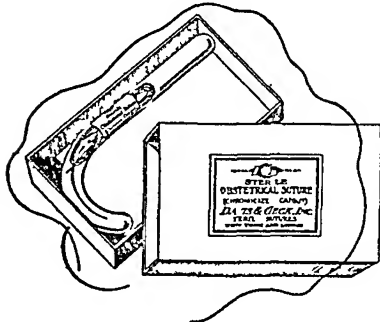
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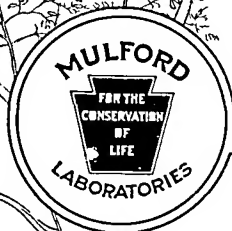
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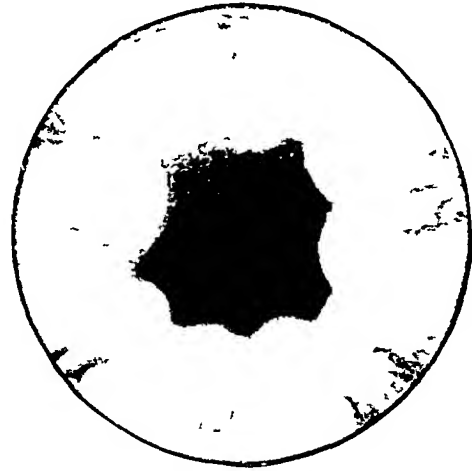
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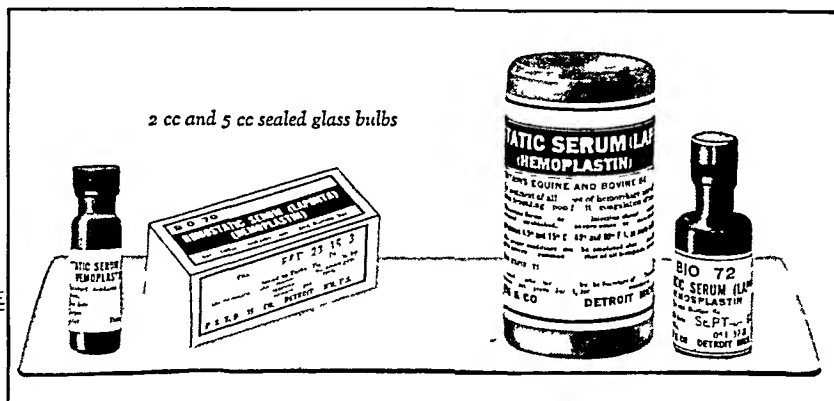
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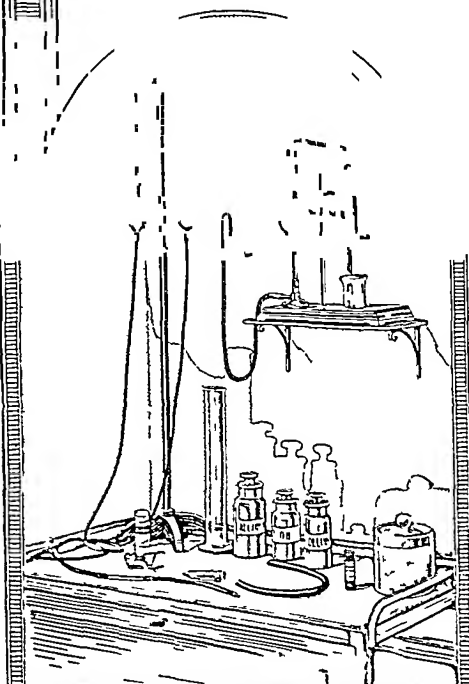
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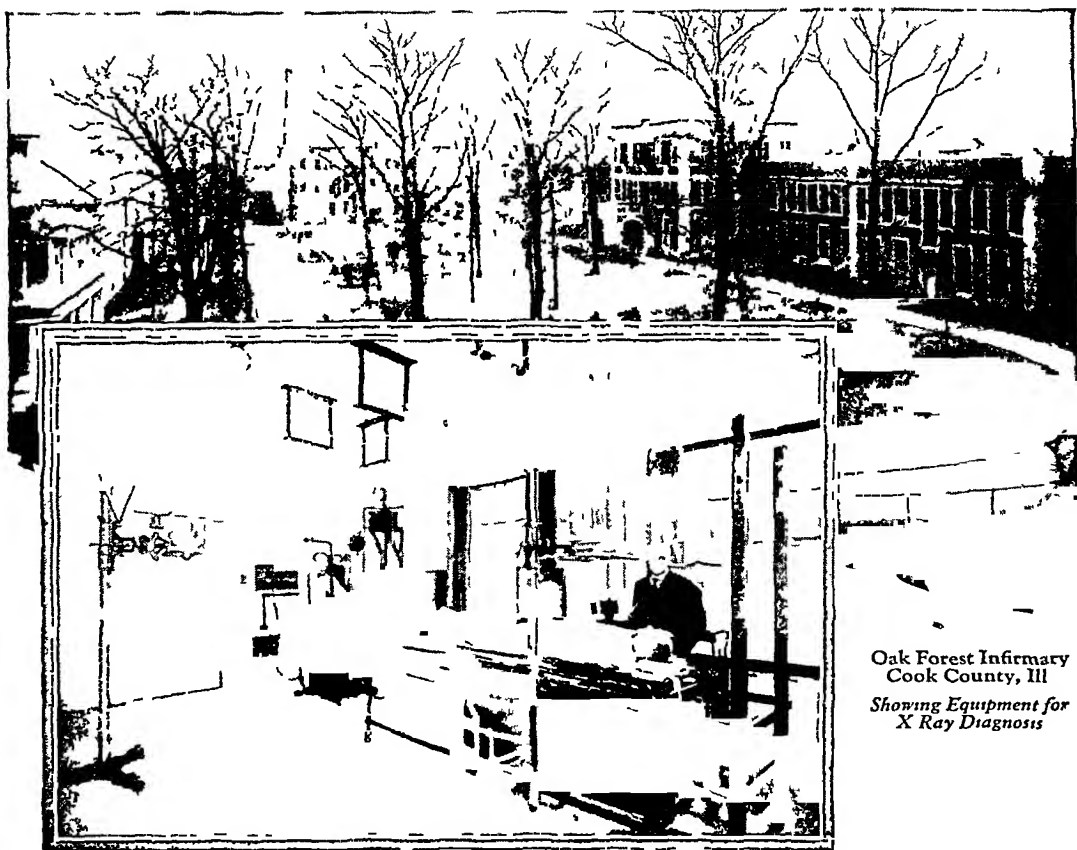
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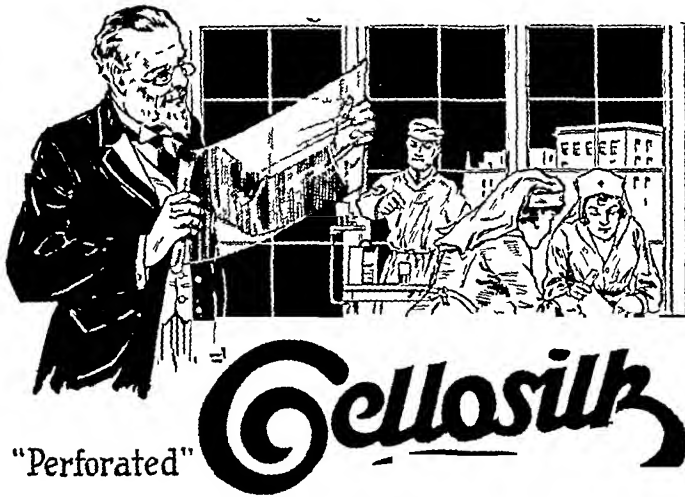
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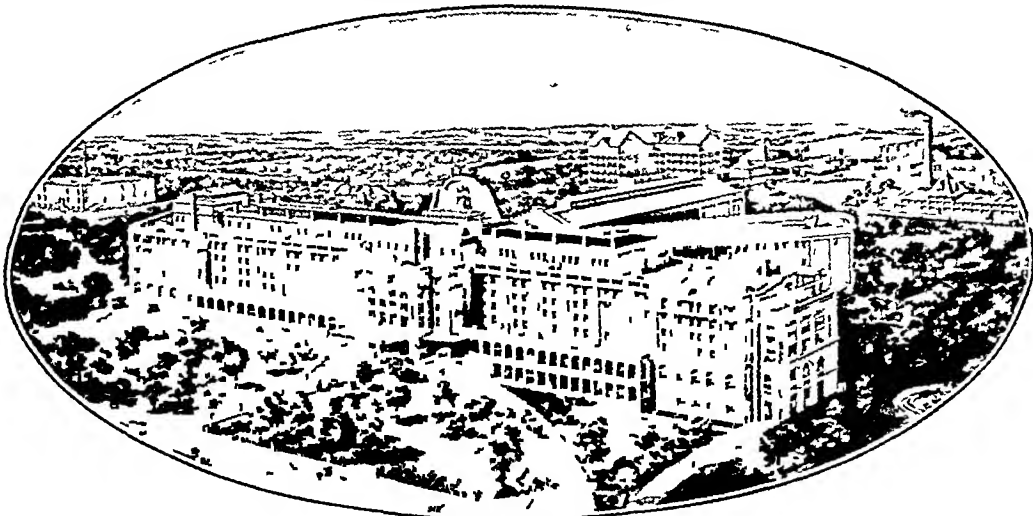
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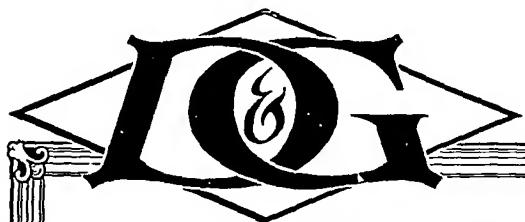
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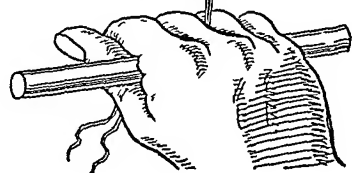
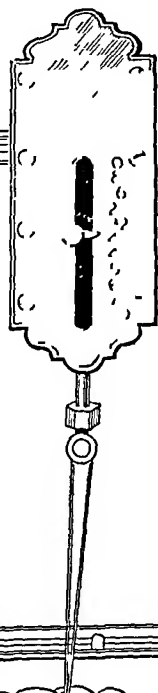
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ANNALS *of* SURGERY

VOL LXXIV

SEPTEMBER, 1921

No 3

THE MAKING OF A SURGEON

BY JOHN B. ROBERTS, M.D.
OF PHILADELPHIA, PA.

ABSTRACT OF PRESIDENTIAL ADDRESS DELIVERED AT THE MEETING OF THE AMERICAN SURGICAL ASSOCIATION,
JUNE 14, 1921,

EDUCATION in the Medical Specialties has been given a great deal of attention by our profession within recent years. Surgery has been developed to such a degree of accuracy that the training of those fitted to practice its various subspecialties satisfactorily, honestly and safely has become of paramount importance. The mental and moral equipment of a medical graduate seeking professional and public support in his operative surgical efforts should be subjected to a searching analysis.

This organization of teachers and research workers in surgery is one of the agencies which may well devote time to the consideration of The Making of Surgeons. The President therefore has grouped observations of some early writers on surgical teaching from the time of Paracelsus down to the present century.

When Paracelsus at the University of Basel, in Switzerland, insisted that he would teach not in the Latin of the scholastics, but in the language of his hearers, and laid stress on personal observation and research in surgical education, he opened the way to modern surgery. Arderne and Gale, in England, subsequently prepared text-books in English for the training of anatomists and operators. Later, John Hunter and his pupils developed the surgical science and art in England, from which our particular Fellowship has largely drawn inspiration and skill.

This line of study soon brought me to the lives and work of men with whom we who now guide, to a considerable extent, the surgical thought of our respective medical schools and communities came into personal contact.

A review of the methods of study which developed Samuel David Gross, the founder of the American Surgical Association, William Williams Keen, a survivor of the original active Fellows, and a glance at the life work of its Associate Fellows, Marion Sims, Joseph Lister, Theodore Kocher, Victor Horsley and William C. Gorgas, give evidence of what is needed to make Surgical Science have a spirit of efficiency, mercy and altruism. These men have transmitted to this assembly of my colleagues a glorious heritage.

A conviction has been brought to me, by these studies, that a maximum

of success up to the limit of an individual's native capacity may be best obtained by certain educational equipments acquired prior to the entrance into the undergraduate medical school and after release from the now usual hospital internship

A real surgeon should have knowledge of logic, psychology, ethics and at least a familiarity with the fundamental processes of rather advanced mathematics and of chemistry and physics. Otherwise, how can he be expected to accurately use his reason to understand and interpret the mysteries of biochemistry, physiology, and the physical processes of life?

Similarly he needs, particularly in a surgical career, a working knowledge of general mechanics and should have some training of his hands and fingers, by which his cerebral centres will be stimulated to specific reactions

In addition to an acquaintance with Latin, he should know some Greek. These tongues lie at the basis of medical nomenclature.

With this equipment, let him enter the medical school, wherein among other topics, Medical History should not be neglected.

The hospital internship, now so wisely insisted upon in some States, should be followed by at least one or two years general practice. This should, if possible, be under the partial supervision of an internist of ability, conscientious temperament and endowed with a practical knowledge of how to care for distempered souls as well as impaired bodily organs.

The youth is now ready to begin a preparatory course for a true Chirurgical Life—the happiest, the best and the most glorious of man's efforts for his fellow-men. In this graduate study, he must return to first principles and renew acquaintance with anatomy, morbid anatomy, pathology, physics and chemistry with eyes, ears and a brain of an intellectually receptive mind. The sciences allied to medicine will be part of his systematic study.

He should later make application of his basic education in science and medicine and his renewal of scholastic topics to the diagnosis and treatment, operative, medical and physico-therapeutic, of surgical conditions, under wise guidance, and, finally, by research work in connection with his operative opportunities, take place among the recognized surgeons of his country.

CARCINOMA OF THORACIC ŒSOPHAGUS EXTRAPLEURAL RESECTION AND PLASTIC*

DESCRIPTION OF AN ORIGINAL METHOD WITH REPORT OF A SUCCESSFUL CASE WITHOUT GASTROSTOMY

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OF NEW YORK, N Y

FOR many years cancer of the thoracic œsophagus had been the despair of surgery. Then, in 1913 came the brilliant achievement of Franz Torek, of New York, who relieved a woman over sixty years of age by boldly invading the posterior mediastinum through the pleura and, in the face of discouraging obstacles, extirpating the tumor-bearing gullet. And his patient is alive to-day, swallowing her food through an external tube of rubber which completes the passage between an œsophageal opening in the upper thorax and a gastrostomy. In spite of the perhaps trivial annoyance of keeping two wounds clean, the state of this patient is by no means melancholy, and the success of the operation has been the cause of perhaps hundreds of attempts not only to repeat the feat of Torek, but to place transpleural thoracic resection of the œsophagus among the justifiable operations of surgery. But unfortunately neither Torek himself nor any of his followers has been able to save another of these patients while hundreds of failures have resulted. So surely did the fatality follow the operation that some conservative surgeons believed that Torek's success was far from being a benefit to humanity.

Doctor Bevan, speaking at the 1915 meeting of the American Surgical Association, appeared to doubt the wisdom of continuing the operative attack upon the thoracic part of the œsophagus. For some years radium and the X-rays have taken the place of the knife with what seems to me a less merciful ending, for the last day was merely put off with false hopes, longer suffering and greater expense to the patient or his friends.

Probably the greatest danger in œsophageal surgery has been infection of the mediastinum, whether the avenue of approach has been through the pleura or outside of it, and many experiments have been made to avoid this great peril. At the end of this paper is a list compiled for me by Dr S. Hirshfeld, of New York. It by no means gives all the references in the literature, but it covers the various sides of the subject pretty well.

The only successful cases recorded are those in which some form of œsophagoplasty or anastomosis has been made for benign stricture without resection. Much ingenuity has been shown in devising tubes of skin or hollow viscera, all placed extrathoracically, to side-track the impervious part of the gullet, even the stomach itself having been drawn out of the abdomen and transplanted to take the place of a part of the œsophagus.

About four years ago I began to give serious thought to the problem, and

* Read before the American Surgical Association, June 14, 1921

it occurred to me that in order to avoid mediastinal infection it would be necessary to divide the procedure into at least two parts. First, the exploratory isolation of the œsophagus with obliteration of the mediastinum, and, second, the resection and plastic. I hoped to enter the chest from behind and without invading the pleural cavity. Different levels of the œsophagus might demand various modifications of the method selected, but I finally decided to try out the possibilities with growths occupying the œsophagus below the aortic arch.

I was by no means sure that enough of the pleura could be stripped free

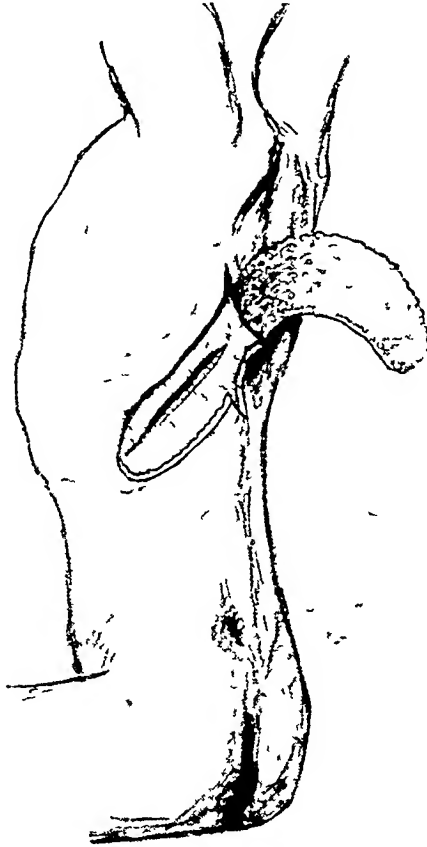


FIG 1.—The skin flap dissected off and the beginning of the incision in the denuded area. The incision may be extended upward or downward posteriorly.

to make safe the work on the œsophagus. I hoped that even if the pleura were to be injured the method itself need not be abandoned. It would simply mean that the interval between the isolation of the œsophagus and its resection would have to be sufficiently long for the pleural infection to have disappeared. Through the kindness of Dr J McAllister I was enabled to test the method on a cadaver in the morgue of Bellevue Hospital. Dr Harold Neuhof, Associate Surgeon to Mt Sinai Hospital, assisted me in this investigation as well as in the operative work on living subjects. I am glad to acknowledge here his sympathy and his resourcefulness which did

much to smooth the way in solving this difficult clinical problem. We found, as I feared, that the pleura stripped with difficulty in the subject upon which we worked, but we believed that another pleura might prove more resistant to handling.

The question came up as to whether the approach should be from the left or the right of the spine, and from a fairly large experience in thoracic surgery I concluded that the left approach, although no nearer the œsophagus than the right, would probably prove simpler and safer. First, because the

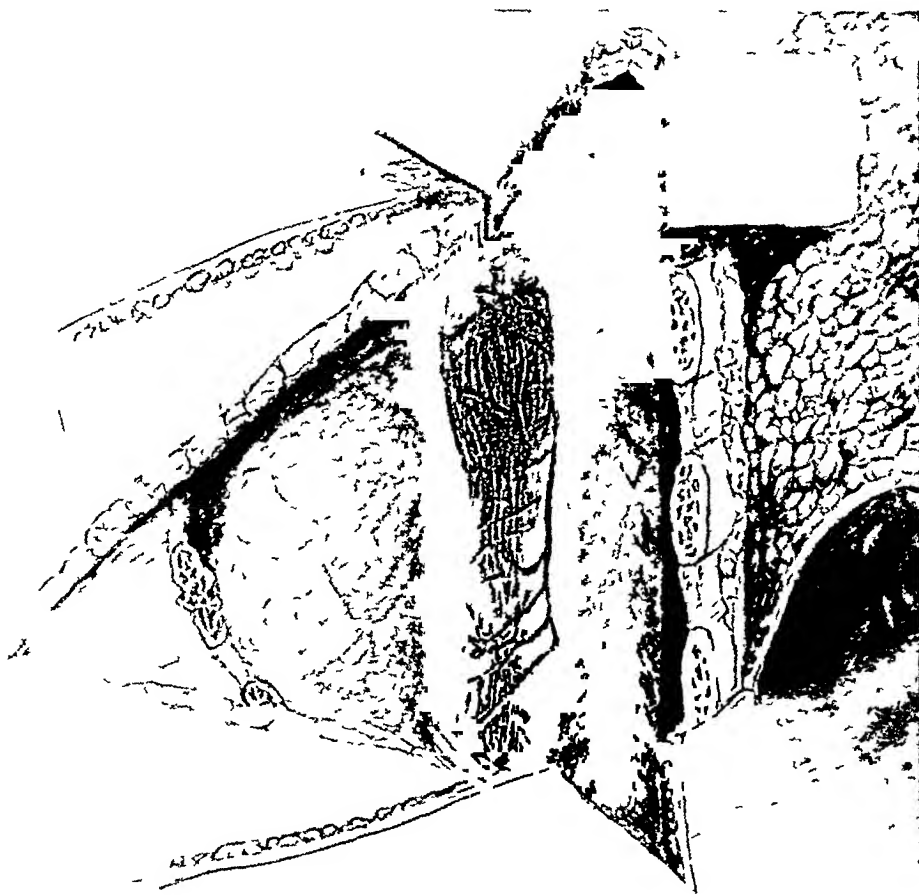


FIG 2—Œsophagus exposure. Note lung covered by pleura. Aorta. Œsophagus and (probably) the right vagus with its plexus gulæ.

descending aorta would form the first important landmark, second, because we would be further away from the important veins and the thoracic duct, and, third, because working on the right side it would be difficult and perhaps impossible to free the pleural fold which crosses the median line in this part of the thorax. Indeed, in doing a left transpleural operation upon the œsophagus I had once entered the right pleura in loosening the gullet from its bed. The demonstration on the cadaver proved conclusively that it was quite feasible to reach the œsophagus through a sufficiently large wound without the resection of many long pieces of rib. It could probably be done even without costectomy, merely dividing several ribs close to the spine, cut-

ting the intercostal structures down to the pleura, then after peeling off the pleura gradually spreading the wound. We finally concluded that the subperiosteal removal of six or seven inches of one rib would facilitate the pleural stripping and subsequent exposure of the mediastinum. I realized that it would probably be necessary to transplant skin by grafting of some kind in order to prevent cicatricial closure of the space between the severed ends of the œsophagus. How this was finally accomplished the history of my case and the illustrations will explain.

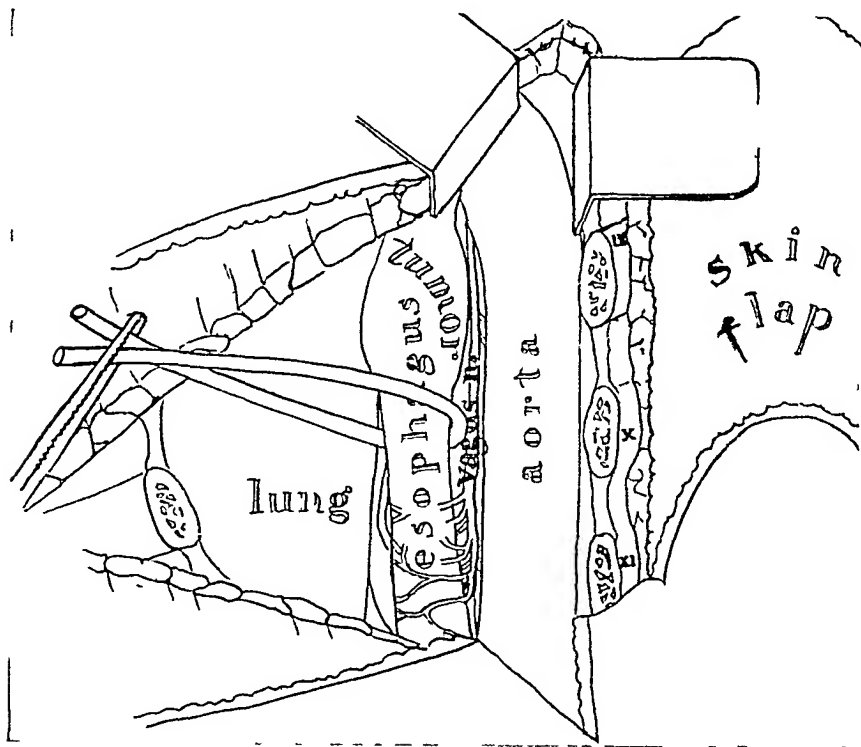


FIG 3—Diagrammatic to explain in part Fig 2. Note also the rubber tube placed round the œsophagus to act as a retractor.

CASE—Davis F, thirty-four years of age, entered Mt Sinai Hospital on December 14, 1920. For a year there had been cough with slight expectoration. There was some nasal obstruction which caused him to be a mouth breather. About nine months before admission he began to suffer pain behind the sternum from the neck to the epigastrium on swallowing solids. For three months he was obliged to wash down his meals with draughts of fluid on account of the presence of an obstruction. I am indebted to Dr Sidney Yankauer for referring this patient to me, Doctor Yankauer having removed through the œsophagus a specimen which was pronounced by Doctor Mandlebaum to be carcinoma of the squamous cell type.

The Wassermann blood examination was reported as 4+. Further examination by Doctor Yankauer failed to show the full extent of the tumor because the obstruction left a passage too small for his instruments to pass. The general physical examination showed nothing remarkable. The urine analysis was negative. The blood was apparently normal and belonged to Group II. There had,

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of course, been loss of weight, but the general nutrition had not greatly suffered. The X-ray films brought by the patient when he entered the hospital were not satisfactory except to demonstrate an obstruction, which could be seen close to the dome of the diaphragm, and a narrow streak of barium running downward from the supposed location of the tumor, through the shadow of the diaphragm until it was lost below. Fluoroscopically there was partial obstruction, which was interpreted by the men of the X-ray staff as being just above the cardia. It is best in these cases not to depend upon the fluoroscope alone, but to have good

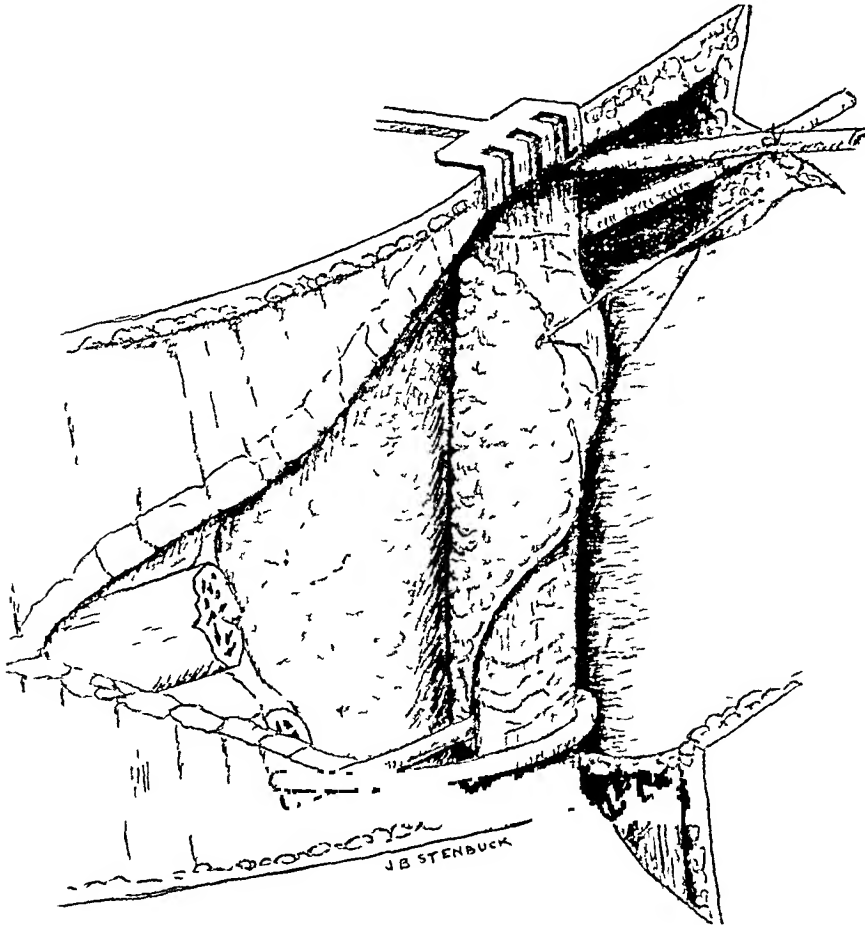


FIG 4—Skin flap partly surrounding œsophagus and held in place by a suture to the chest wall. The two rubber tubes are left in place to act as retractors at the next step of the operation.

plates or films made taking in the entire chest so that the level of the tumor may be designated by the corresponding vertebra.

With a positive diagnosis of carcinoma of the œsophagus, probably low down and reported by the X-ray Department to be "two inches above the cardia," operation was undertaken December 16, 1920. The anæsthetic, nitrous oxide-ether, was administered by Doctor Branower, Doctor Neuhoof acting as first assistant, and Dr. J. Lawrence Jones, House Surgeon, as second assistant.† An intravenous

† I desire to acknowledge the conscientious attention, also, of the surgeons of my House Staff, Dr. L. Mason Lyons having taken the place of Doctor Jones soon after the operation.

injection of six grammes of sodium citrate in solution was administered by Doctor Hirshfeld to reduce the coagulating time of the blood ‡

The patient was placed on his right side, with his knees and hips flexed and the trunk bowed forward. The bridge of the table was raised so as to cause a scoliosis with the convexity toward the left. The incision was made from a point about one and a half inches to the left of the spine along the eighth interspace to the mid-axillary line, then downward and backward along the tenth rib, outlining a skin flap with its pedicle posterior. This flap was now dissected up together with the subcutaneous fat and here and there a bit of fascia and muscle, and turned back and wrapped in warm moist towels. (See Fig 1) Five

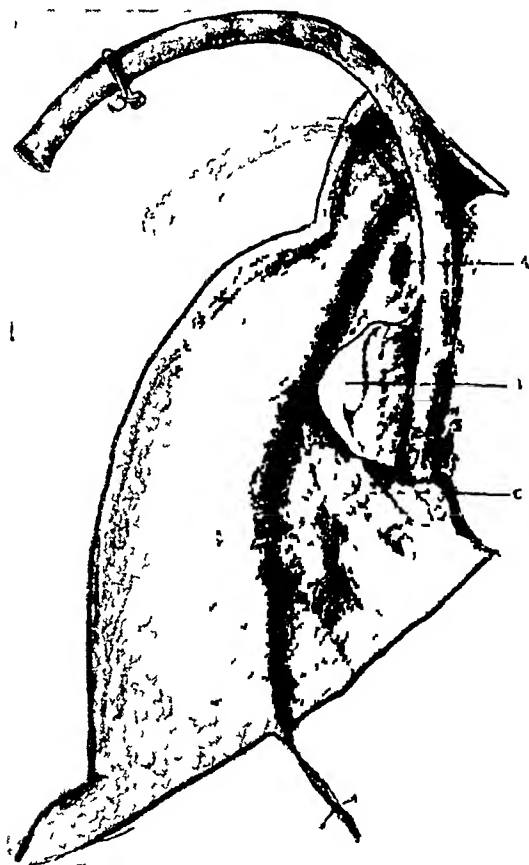


FIG 5—After the resection. Stomach tube in lower esophageal orifice and the skin flap upon which the rubber stomach tube rests. The white portion is the granulating side of the flap, not the epidermal side. The mediastinum is obliterated by granulation tissue which also covers the other structures in the picture.

excellent drawings were finished from sketches made at the operation. The artist is Dr J B Stenbuck, Senior on the House Staff of Mt Sinai Hospital. Through the resulting wound area another incision was made upon the ninth rib, the greater part of which was subperiosteally resected. Beginning toward the back the pleura was dissected with the finger away from the posterior chest wall, and then forward from under the surface of the tenth rib, which was

‡ A method of Dr Harold Neuhoef. See paper by Neuhoef and Hirshfeld in New York Med Jour, Jan 15, 1921, vol cxi, No 3, p 95

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divided posteriorly close to its angle, after it had been freed from the underlying pleura. With the pleura peeled away and the lung pushed forward with it, the structures in the posterior portion of the thorax were exposed and easily recognized (Figs 2 and 3). The first important landmark was the great splanchnic nerve and the next the descending aorta from which the pleura separated easily. A stomach tube was passed through the mouth into the œsophagus down to, and finally through, a resistance (at the level of the tumor) which had been quite easily overcome, then on into the stomach. The œsophagus below the tumor was thus rendered palpable as it lay anterior to the aorta drawn forward by its connection with the pleura much as the ureter is drawn forward

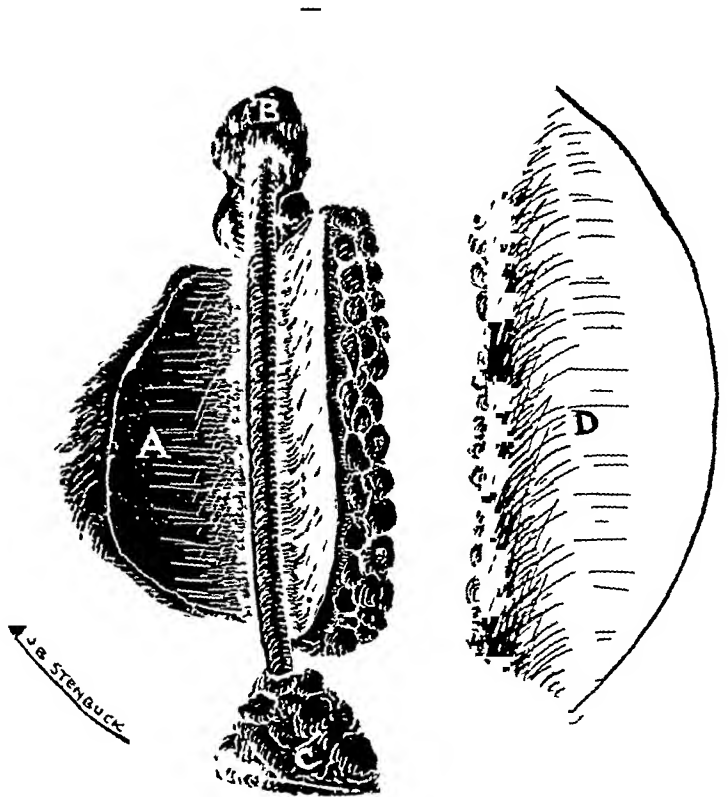


FIG. 6.—Skin flap cut through and rolled over a rubber tube toward the tip of the flap A. D is the pedicle of the flap now no longer a part of it. B and C are the upper and lower œsophageal openings bridged by the tube.

with the peritoneum. No tumor was felt as far down as the opening through the diaphragm, which, by the way, was exposed with ease, and the opening explored with the finger. A portion of the eighth rib was now freed from the pleura and a short resection done. Then the seventh and sixth ribs were divided posteriorly, also extrapleurally, and the rib separator introduced retracting the entire wound, especially the upper portion. The lower part could be exposed even without the rib spreader. Now the tumor could be distinctly felt as a fusiform enlargement of the œsophagus about three inches below the arch of the aorta and extending upward to about one and a half inches below the arch. The œsophagus was isolated and the right pneumogastric nerve freed from it, dividing the branches with scissors so that the nerve lay on the posterior wall of the chest. Following the advice of Torek this nerve had been anesthetized with five per cent cocaine solution on a pledget of cotton. The left vagus was not seen

It was probably separated bluntly from the œsophagus during the freeing of this structure from the pleura. A thin rubber tube was now passed around the œsophagus above the tumor and another below it, these tubes acting as suspension ligatures so that the œsophagus with its tumor was nicely exposed, making a beautiful demonstration for spectators. The skin flap was now placed in position, lying between the vagus and the gullet, its cuticular surface being next to the œsophagus and its terminal portion being turned around the viscus so as to form a trough of skin to be completed into a tube by the division of the pedicle of the flap at another time. The skin flap was held in position by a suture of silk running from the tip of the flap to the inner part of the chest wall (Fig 4). Thus far the pleura had remained intact, but now an additional portion of the

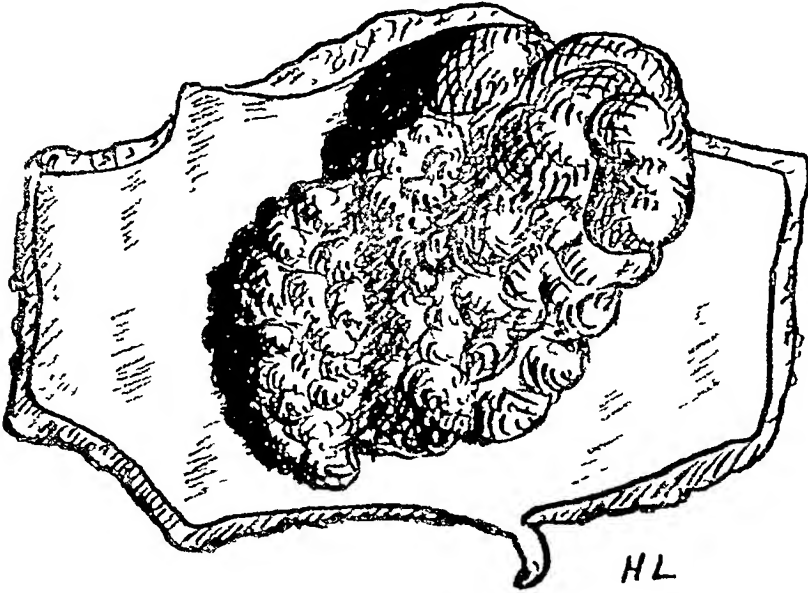


FIG 7 —The tumor. Œsophageal segment laid open. The line below is the natural size.

eighth rib was resected and there occurred an accidental tear about one-half centimetre square. The lung which had been sliding smoothly against the inner side of the pleura changed its appearance the moment a little air entered, but the opening was quickly and completely closed by catgut sutures. Three heavy chromicized catgut stitches placed pericostally between the tenth and eighth ribs approximated what remained of these ribs, and the anterior part of the wound was closed by suturing the divided muscles, the posterior portion remaining open.

Dressing—The pleura was covered with a large piece of rubber dam extending down as far as the œsophagus which, with its partially surrounding skin flap, lay at the bottom of the wound in its normal position. The remainder of the wound was lightly packed with gauze so as not to make pressure on the flap. No bandage or binder was used, the dressing being held in place by adhesive strips.

There was no shock following this extensive procedure. The patient lay comfortably on his right side. There was some mucus in the trachea, but the man was strong and easily able to expel it. He swallowed better than before the operation, possibly because of the dilation by the stomach tube. His highest temperature was about 102°, his pulse 112, but always strong.

My next note is December 23rd, one week after the operation. The gauze

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had been removed and replaced and the rubber dam had been taken out a day or two before. The tongue of skin flap which surrounded the œsophagus was slightly discolored, but only about one-half inch at the tip finally necrosed.

December 29th, the wound looked well and granulation had begun. The cough had persisted with about two ounces of expectoration in twenty-four hours. Later it completely disappeared.



FIG 8—X-ray in oblique position about three months after the operation. Thick barium mixture. The arrow points to the new œsophagus (the part made from the skin flap). This part is partially empty. Note structure above it.

December 29th, thirteen days after the operation, swallowing became increasingly difficult, so it was decided to perform the second step without delay. A hypodermic of one-fourth grain of morphine and one-one hundred and fiftieth grain of atropine was administered and the patient taken to the operating room. Doctor Neuhof and Dr. Ira Cohen assisted at this stage, and we were glad to have Doctor Torek present as a spectator. There was no anæsthesia, either local or general, and the patient sat up across the table bending forward and making no complaint throughout. Granulating adhesions between the ends of the severed ribs were broken down with the fingers and large blunt retractors were used to

expose the depths of the wound. Adhesions had taken place between the œsophagus and the underlying structures and even between the œsophagus and the edges of the skin flap. It was easy to find our way, however, because of the long rubber tubes which had been left around the œsophagus at the close of the previous operation. The entire œsophagus was covered with healthy granulations, but the tumor was still both palpable and visible in spite of this.

The œsophagus was entered with scissors just above the tumor and an



FIG 9.—Five months after operation. The wound is healed. X-ray in oblique position, with thick barium mixture. The stricture has been dilated. The arrow points to new œsophagus.

incision was made transversely below it. With one blade of the scissors in the lumen, the œsophageal canal was opened in a sagittal direction so that the finger could be inserted for exploration. The tumor limits were easily made out, the cross section of the gullet above was completed, the diseased segment drawn with forceps out of the trough of skin, and the resection completed below. An immediate examination of the specimen showed that we were well beyond the limits of the growth, but to make doubly sure a small segment above this was cut away with the scissors. Hemorrhage was slight, no vessels being caught and no spurters seen. There was a little oozing in the upper portion of the wound. The

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FIG 10 —A red rubber stomach tube has been passed by the patient. In this oblique position the canal appears fairly straight.

skin flap had already formed a trough and the mediastinum was sealed off by it and by granulation tissue. A "T" tube had been prepared, the cross-bar of which was to enter the upper and lower portions of the œsophagus while the upright protruded from the wound for feeding. This proved impossible, however, because the injected fluid went in both directions and regurgitated from above. A swallow of water at once demonstrated that there would be escape alongside of the tube in the upper segment of the œsophagus. The whole wound was lightly packed with gauze and the patient sent to bed in splendid condition. His color was good, his pulse strong and there was a smile on his face. About one and a half hours later, however, it was found that he had bled considerably from a small artery in the upper segment of the œsophagus. Retractors exposed the depths of the wound and the vessel was caught by Doctor Neuhof with a clamp, which was left in place. Although the pulse had risen to 120 and the patient was pale and somewhat shocked from the loss of blood, his condition was not desperate. A second dose of sodium citrate was given by Doctor Hirshfeld subcutaneously, this time although all the bleeding had ceased since the vessel



FIG 11—Antero posterior view at same sitting as Fig 10 Note bend in œsophagus

had been clamped. A few hours later the pulse-rate had receded to 116 and there was great improvement. Still not wishing to omit any precaution, I requested that a transfusion be performed, and this was done by Doctor Ottenberg, who injected 500 cc of blood by the citrate method. From that time on the patient never gave us a moment's anxiety so far as danger to his life was concerned. Two days after the operation he was able to sit up during the dressing and the clamp came away without mishap. The "T" tube having proved useless was replaced by a stomach tube, passed through the wound into the lower segment of the œsophagus, and thus he was fed with the aid of a funnel and without regurgitation (Fig 5). Another tube, its lower end tied off with a string, was passed into the upper segment of the œsophagus for about five inches and left there to maintain patency. Five days after resection the wound was nicely granulating and a full-sized stomach tube passed through the mouth appeared in the wound.

About four days later a distinct, though slight, contraction was noted at the opening in the upper segment of the œsophagus. An Einhorn tube was placed in the stomach through the mouth, and through this the patient was fed for several weeks, milk, egg, and sugar being injected with a syringe.

January 12, 1921, I cocainized the pedicle of the skin flap and divided it at the angle where the flap dipped into the chest. It was then dissected away from the inner part of the chest wall and turned over the œsophagus so as to form a

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rude tube (Fig 6) It was hoped that the entire wound would now fill with granulations and that the case would soon be ended The flap, however, proved to be most obstinate in its tendency to return to its normal position During the next few weeks it had firmly adhered to the chest wall three times in spite of every effort to hold it in place with sutures and packing until finally I was forced to let it have its way for the time being



FIG 12 —Wound healed after plastic operation

On January 26th, the granulations looked a little flabby and anti-syphilitic mixed treatment was begun When the patient swallowed a glass of water about four drams of the six ounces entered the stomach

February 8th, the mixed treatment had been followed by an improvement in the appearance of the wound For the next few weeks the patient was fed entirely by mouth, the Einhorn tube having been removed and replaced by a large tube, forty-four calibre, which was passed through the wound into the openings in the œsophagus so as to bridge the gap and was kept from slipping into the stomach by a stout silk ligature which emerged at the margin of the wound and was strapped to the patient's back Through this tube he was able to take fluids and semi-solids by mouth, and I hoped that when granulation should have closed the defect that the tube might be removed by way of the mouth through the œsophagoscope Some days later, however, this tube became disarranged and the patient strangled and was distressed so that it had to be removed through the wound The man was rapidly gaining in weight and his general appearance be-

came normal. His wound was packed with rubber dam several times a day which stopped the opening in the back so that he now took all his nourishment by mouth, liquids and semi-solids, with but little leakage, and I thought we were on the last lap of this trying surgical contest. It soon became evident, however, that obstruction at the end of the upper œsophageal segment was increasing and it was more and more difficult to pass bougies. Evidently, too, there was a tortuosity in the new œsophagus, and this was later demonstrated by the X-ray (Figs 8, 9 and 11). Doctor Yankauer dilated the upper opening with the aid of the œsophagoscope, but the straight instrument could not be made to pass into the stomach. Meantime the external wound was allowed to close until only a small fistula, say about twelve French, persisted, the remainder having cicatrized firmly, but because of the increasing difficulty in passing bougies from the mouth to the stomach I felt that it would be necessary to reopen the wound, so, on March 31st, without anesthesia, this was done. The new œsophageal lining was exposed by cutting through the posterior line of union which proved to be tough and cicatricial. It was with great reluctance that I sacrificed the skin union so long and anxiously awaited

The cutaneous lining of the œsophagus was white and looked normal, although in the neighborhood of the external wound there was dermatitis and excoriation evidently from the presence of decomposing food. The finger in the wound detected the upper and lower œsophageal apertures, the lower easily admitting the index finger, the upper being much contracted. It is possible that this phenomenon might be accounted for by disturbance of the nerve supply to the lower segment. A silk string was swallowed by the patient and a tightly fitting rubber tube was drawn through the upper segment of the œsophagus and left there to stretch the stricture for twenty-four hours, a small stomach tube being inserted through the cardia for feeding. Although there was good dilatation by the tube, contraction again occurred in spite of the daily passage of instruments. The condition was enough to try one's patience to the utmost and I began to hear hints that a gastrostomy might simplify things. This it certainly would have done for it would have permitted the easy dilatation of the strictures with bougies tied to a swallowed string emerging at the gastrostomy wound. But I had set my heart on completing the case without opening the stomach. Finally, I was persuaded by Doctor Neuhof to reopen the wound and to expose the upper and lower orifices to inspection, dealing with them as might appear necessary. Accordingly I did this on April 28th, without general anæsthesia, but using a little cocaine locally. With retraction there was perfect exposure of the two apertures. Both had united nicely with the skin, but the upper was a mere slit with a tough cicatricial ring forming a collar about it. With a probe-pointed bistoury several radiating incisions were made until the largest sized bougie, about No. 50, could be passed without difficulty. The lower opening was treated in the same manner and for the same reason, although the contraction here had been slight. A piece of the contracted skin was removed for microscopic examination. It showed nothing remarkable.

The patient then began to pass a No. 45 stomach tube himself, and I felt the time had come to close the thoracic wound. On May 5th, I performed, in general anesthesia, what I hope will be the final operation in this case. Thoroughly denuding the edges of the vertical wound in the new œsophagus, I closed it with interrupted chromic gut sutures, leaving a small opening below. I then dissected up the skin of the back, forming two flaps, one on each side of the wound, and sutured them together.

On May 11th, healing had so far proceeded that the patient swallowed liquids naturally and without losing a drop. Four times a day he passed a No. 45 stomach tube. He could take ordinary food made into a mash or after thorough

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mastication The wound had healed soundly in the depths and there remained but two small flat granulating areas on the back where the flaps had been slid at the last operation He was discharged otherwise apparently well on May 19th It is intended that he shall pass the bougie several times a day for the greater part of a year or until there is reason to believe that the cicatrix will no longer contract Davis F. was an ideal individual for pioneer work If he was nervous he never showed it, and he cooperated in every possible way, enduring pain and great discomfort without complaint Also, he evinced in a detached way keen interest in the outcome of his case

The history of this case is that of my first completed operation of extra-pleural resection of the œsophagus without gastrostomy, and I believe it is the first in medical history Four other patients upon whom I have made exploratory mediastinotomies for carcinoma of the œsophagus died and in every case the tumor had extended beyond the œsophagus Three of the deaths were caused by infection of the mediastinum through injury to the diseased œsophagus while attempting to isolate it In the fourth, that of Mrs U, I have not been able to explain satisfactorily the operative death, although reference to the post-mortem notes will show that the case was inoperable Abstracts of the four histories follow

CASE I—R A, male, fifty-six years of age, entered Mt Sinai Hospital, October 14, 1919 "For a number of months there had been vomiting and regurgitation of solid food immediately after swallowing until finally only water could be taken by mouth" The patient was cachectic and emaciated, with râles at both bases The stomach tube was obstructed 45 cm from the teeth X-ray examination showed complete obstruction at the lower and middle thirds of the œsophagus. October 30, 1919, a Witzel's gastrostomy was performed by Doctor Neuhof Specimen removed by Doctor Yankauer through œsophagus Reported by Doctor Mandlebaum "squamous-cell carcinoma" Mediastinotomy was done on November 13, 1919, by me Intratracheal anæsthesia by Doctor Branower The long posterior eighth interspace incision was made and the eighth, ninth and tenth ribs were divided behind their angles Owing probably to previous pleuritis there was complete obliteration of the left pleural sac by adhesions This facilitated the operation The flap of chest wall made by the incision just described was turned down and the aorta easily exposed for at least eight inches The œsophagus was located with a bougie passed through the mouth and the tumor was easily reached It was much larger than expected and was adherent to the pericardium and lower part of the left lung The lower limit could not be ascertained because the growth seemed to pass through the diaphragmatic opening The adherent lung was divided between ligatures and the œsophagus above the tumor was mobilized after cocainization of the vagus Pus was encountered close to the tumor and the operation abandoned The wound was closed with drainage posteriorly No shock followed the procedure Two days later the wound was dressed, the patient sitting up in bed without assistance There was infection, however, from the suppurating tumor and death occurred four or five days after the operation No autopsy

CASE II—John F, aged fifty-six, had had great difficulty in swallowing solids for only six weeks When he was admitted to Mt Sinai Hospital there was extreme emaciation and the X-ray showed œsophageal obstruction opposite the seventh dorsal vertebra with a filling defect extending downward for three inches and with dilatation above There was inequality of the pupils but the

Wassermann test was negative On June 24, 1920, Doctor Neuhof assisting, and Doctor Branower administering the anæsthetic by the intrapharyngeal method with ether, I operated A long seventh interspace incision curved downward posteriorly over the eighth, ninth and tenth ribs The eighth rib was resected subperiosteally and the ninth and tenth ribs divided posteriorly through the periosteum, the finger holding the pleura off from the ribs The pleura was then further stripped away exposing the posterior mediastinum, but it was wounded in several places and not sutured The exposure was excellent with the aid of the rib spreader and the neoplasm was easily found There was an infected gland, and considerable time was spent in dissection The tumor was firmly adherent to the aorta and the operation was discontinued In dissecting the œsophagus with the stomach tube in place the musculature of the wall was injured so that the tube was clearly seen through the mucosa and eventually it was shown that infection took place here The wound in the chest wall was closed by suture, the skin being left open There was but little shock and two days later the patient swallowed fluids better than before, owing to the stretching of the œsophagus by the stomach tube After that, however, general wound infection rapidly progressed and he died a few days later

CASE III—Samuel R, sixty-eight years of age, entered Mt Sinai Hospital March 2, 1921 He had had "dropsy" thirteen years before For two and a half months there had been regurgitation of food with difficulty in swallowing and with pain in the epigastrium and lower sternal regions The patient was obviously old and emphysematous The X-rays showed almost complete obstruction of the œsophagus near the stomach March 3, 1921, gastrostomy was performed by Dr Ira Cohen, Adjunct Surgeon Pneumonia followed, although local anæsthesia had been employed Then there was a double suppurative parotitis which finally yielded to massage At last, on April 4, 1921, it was considered safe to perform the mediastinal operation Nitrous oxide and ether anæsthesia Because of the complete obstruction in this case continuous suction was carried out with a small-sized œsophageal tube which was inserted as far as the stricture To make the suction more effective a dozen perforations were punched out of the wall of this tube The object of this suction was to get rid of the fluids which might have entered the œsophagus, gradually filling it up to a point of overflow and causing aspiration pneumonia The long flap was isolated, and the first steps of the operation were similar to those described in the successful case The pleural cavity was unavoidably entered in several places, the operation proceeding, however, under intrapharyngeal insufflation Two ribs above the ninth, and also the tenth rib, were divided posteriorly, the pleura being here easily stripped away Working upward, now, I was surprised to see the entire posterior pleura as far as the mid-axillary line fall away from the costal and mediastinal chest wall The pleura, however, was as fragile as wet tissue paper and was torn many times The aorta and great splanchnic nerve were seen, the œsophagus palpated, and the tumor easily found The upper limit was sharply marked about two inches above the diaphragm, but the lower limit was not reached, although it was believed to be above the diaphragm While attempting to isolate the normal part of the œsophagus the right pleura was suddenly entered There was a sound of rushing air, but the opening could not be seen The heart's action became very irregular, the patient turned cyanotic, respirations were shallow, and at last it looked as though the man were dead Thinking that the cardiac collapse was perhaps due to vagus disturbance, a pledget of cotton with five per cent cocain solution was placed for a few moments in the wound over the nerve and the wound in the chest fully closed To my surprise the patient gradually recovered so that he left the table in good condition About forty hours after the operation, however, he sank and died

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The post-mortem inspection showed that the tumor had invaded the stomach, although that had not been ascertained at the time of gastrostomy. The right pleura had been entered and contained air and bloody serum. Death was apparently due to cardiac disturbance caused by pneumatic and circulatory changes in both chests. Pathological report of tumor by Doctor Mandlebaum was "adenocarcinoma with pearl formation."

CASE IV—Mrs L U, forty-four years of age, had suffered from palpitation and dyspnoea on exertion for several years. She had also had an attack of œdema of the extremities seven months before I saw her. She entered Mt Sinai Hospital on April 12, 1921, with a temperature of 101° F, pulse 84 and respirations 24. For six months there had been dysphagia and vomiting and loss of weight. There was much pain in the chest on deglutition. The patient was badly nourished and poorly developed. There were râles at the left apex with slight dullness. There appeared to be some cardiac enlargement with a systolic murmur at the apex. The spleen was palpable. The urine showed nothing abnormal. By the X-ray there was great narrowing of the œsophagus at the level of the seventh dorsal vertebra with a defect below. The patient could take the thick barium mass, but it passed through the stricture slowly. On April 13th, by œsophagoscopy, Doctor Kaempfer removed a tiny specimen which twenty-four hours later was reported by Doctor Mandlebaum as probably carcinoma, though the specimen was hardly sufficient for complete examination. Bleeding had greatly embarrassed the œsophagoscopy but Doctor Kaempfer said that inspection strongly suggested carcinoma.

On April 14th operation was performed. Doctor Branower administered nitrous oxide and ether by the intrapharyngeal method and Doctor Neuhoef assisted at the wound. A perforated stomach tube with suction was used to keep the œsophagus free from secretion. The skin flap was made as in the first case, with its midline along the seventh rib, and about five inches of this rib were then resected subperiosteally and the pleura peeled away without injuring it. The sixth, fifth and fourth ribs were divided near the spine, and later the eighth rib as well. The great splanchnic nerve and the aorta were plainly visible. The tumor was found. Its upper limit was about one and a half inches below the aortic arch, but its lower limit was not palpable. No instrument could be passed through the stricture to facilitate the identification of the lower œsophagus. The upper part of the growth was firmly adherent to the aorta and it was peeled away with difficulty, this procedure being preceded by cocainization of the vagus. It looked as if small portions of the tumor remained adherent to the aorta. Further dissection showed that the growth could not be freed from the pleura, so, fearing that I might wound the already eroded œsophagus, the operation was abandoned, though I hoped that it might be completed at some future time. The patient died, however, thirty-three hours after the operation, after a period of deep cyanosis with loud rattling in the trachea.

The post-mortem examination through the wound showed a large ulcerating carcinoma which had completely and widely perforated the œsophagus and was on the point of entering the pleura, indeed there were pleuritic adhesions here with a few flakes of fibrin and a minute quantity of turbid exudate.

From the experiences outlined in this paper, together with six other cases of transpleural exposure of the œsophagus with one recovery, a patient with œsophagospasm which was later dilated (ANNALS OF SURGERY, vol 64, 1916, p 94), I have reached the following conclusions:

- 1 That transpleural resection of the œsophagus has a forbidding mortality

2 That fatal infection follows the primary opening of the œsophagus within the mediastinum

3 That it is feasible to make an extrapleural exposure of the posterior mediastinum large enough to permit the operator to see clearly and to work safely with both hands in the wound

4 That resection of the œsophagus in the posterior mediastinum can be done by dividing the operation into two stages At the first the œsophagus is freed from its attachments and the mediastinum is sealed At the second, ten to fourteen days later, the resection is performed *

5 This procedure deserves a fair trial by thoracic surgeons

OPERATIVE PROCEDURES AND SUGGESTIONS FROM THE LITERATURE

DORSAL MEDIASTINOTOMY

NASILOFF (Vratch, 1888, No 25) resected the third to sixth ribs on cadavers to expose the mediastinal portion of the œsophagus extrapleurally

QUENU and HARTMANN, working on cadavers, did subperiosteal resection of portions of the third, fourth and fifth ribs

POTARCA discusses which is the better side for approach

BRYANT builds a quadrilateral flap The middle rib of the flap is entirely resected The other ribs temporarily resected (Experimental only)

OBALINSKI discusses the side of approach

L REHN builds a large skin and muscle flap from the spinous process of the third to ninth dorsal vertebrae Resects several ribs

VON HACKER discusses side approach, as also Bourienne

Note—The first experiments on animals were made by Nasiloff After this a number of surgeons operated not only upon dogs and human cadavers, but also upon the *living human subject*

REHN, LLOBET, TUFFIER, FAURE, KUTTNER also tried these methods, but none of their patients survived, all the operations were extrapleural

ŒSOPHAGOPLASTICS (NOT RESECTIONS)

WULLSTEIN, 1904, mobilized a piece of jejunum far enough under the skin of the thorax to complete an œsophago-jejunostomy with the upper end of the œsophagus (An external plastic No resection of the œsophagus) *Deutsche med Wochenschr*, 1904, No 20

ROUX, 1907, œsophago-jejuno-gastrostomy *Semaine Med*, 1907, iv

HERZEN employed a modified Roux method and reported a success He shortened the path of the jejunum by a slit through the mesocolon and gastrocolic and omentum and brought the gut up through this to the subcutaneous chest (Anterior)

BIRCHER, 1894 and 1907, connected the œsophagus in the neck with the stomach though a tube made of cutaneous tissue, an œsophago-dermato-gastrostomy A fistula formed, as was also observed by Payr in a similar operation *Centralbl f Chir*, 1907, No 51

ESSER, 1917, tunnelled a path in the subcutaneous tissue and used Thiersch grafts The grafts were put around a glass tube (No note of end results)

KELLING, 1914, used the transverse colon Œsophago-colo-gastrostomy (Failure) *Centralbl f Chir*, 1913

LEXER, 1911, combined various types Œsophago-dermato-jejuno-gastrostomy, or œsophago-dermato-colo-gastrostomy

* The only patient whose case was operable and upon whom both steps of the operation could be done recovered Case of Davis, F, page 4

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HIRSH, 1911, used a pedicled flap made from the entire thickness of the anterior wall of the stomach

JIANU, 1912, made a flap of the greater curvature of the stomach containing the left gastroepiploic artery

REHN and ROPKE proposed making use of the stomach plus the healthy distal stump of the œsophagus, after resecting it in the middle (Modification of Jianu)

First, v FINK, then ENDERLEN and HOTZ, mobilized the stomach, closed the distal portion of the duodenum, did a gastroenterostomy, then brought the duodenal end of the stomach subcutaneously into the chest wall

KIRSCHNER mobilized the entire stomach and brought it up into the anterior chest wall subcutaneously, making a gastrostomy opening in the chest, then connecting the stomach with the cervical portion of the œsophagus (Kirschner's article reviews to 1920 the work in œsophagoplasty)

HOFFER and KOFLER, 1917, built a skin flap with its base at the vertebral column, and later made a tube of œsophagus This work was done on the cadaver only*

BUDDE, 1921, built a tube of skin fascia and muscle around a glass rod, then implanted the tube between the cut ends of the œsophagus extrapleurally This was done on the cadaver

FAURE, LLOBET and TUFFIER all attempted to resect the œsophagus extrapleurally, but failed

OTHER PROCEDURES

JIANU-ROPKE *Gastrostomie und Œsophagoplastik* Deutsche Ztschr f Chir, vol cxviii, s 383, 1912 A tube was fashioned from the greater curvature of the stomach but left attached at the fundus, this tube being brought up under the skin almost as high as the clavicle An end-to-end anastomosis with the upper end of the œsophagus

KIRSCHNER Four cases Two for stricture One, an œsophago-gastroplasty for stricture, alive and well The second, a stenosis of the œsophagus with lung abscess, died of lung complications and infection fourteen days after operation There were two cases of *carcinoma* of œsophagus The first, incision in the seventh left intercostal space Intrapleural Inoperable because of metastases The second patient died of mediastinitis

HALSTED Jour Exp Med, 1909, 373-391 (Work on thoracic aorta) Tracheotomy—insufflation of lung Incision in seventh interspace Rib spreader used

ENDERLEN made a rectangular flap with its base to the spinal column from the spinous process of the third to the ninth dorsal vertebræ and extending to the mesial aspect of the scapula All soft parts were divided down to the ribs and turned back The periosteum was dissected away from the ribs, and pieces of rib, 10 cm in length, were resected

HENLE and ENDERLEN operated for removal of foreign bodies—dorsal mediastinotomy Henle's patient died nine days post-operative Enderlen's patient was discharged *cured after nine months*

Note—No surgeon operating for non-cancerous stricture of the œsophagus attempted resection All made use of external œsophagogastronomy or some other complicated procedure

SOME CONTRIBUTIONS TO THE SURGERY OF THE ŒSOPHAGUS AND POSTERIOR MEDIASTINUM

ACH Beitrag zur Œsophagus Chirurgie Verhandl d deutsche Gesell f Chir, 1913, vol xlii, p 260

* This suggestive work was unknown to me when I devised my operation The periodical in which it was published (Munch med Woch, 1917, No 34) is not yet available to me (H L)

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* The four references with the asterisk practically cover this field

CERTAIN PROBLEMS CONCERNING FRACTURES OF BONE*

BY CHARLES L. SCUDDER, M.D.

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OUR problems to-day have been the problems of the ages. Listen to what the wise Greek surgeon, Hippocrates, said in 400 B.C. in writing of fractures:

"I know physicians who have the reputation of being skilled in giving the proper positions to the arm in binding it up after fracture, while in reality they are only showing their ignorance. But many other things in our art are judged of in this manner, for people rather admire what is new, although they do not know whether it be proper or not, than what they are accustomed to, and know already to be proper, and what is strange, they prefer to what is obvious." "And," Hippocrates continues, "I must now state what the mistakes of medical men are, which I wish to unteach," etc.

Under the term *Fractures of Bone* I would eventually, when ideal conditions obtain, include the following:

- Fracture of the skull, protector of the brain,
- Fracture of the spine, so adequately shielding the cord from injury,
- Fracture of the thorax, with possible damage to the contained pleura, lung, and heart,
- Fracture of the pelvis, containing abdominal organs sometimes seriously damaged,
- Fracture of the long and short bones of the upper and lower extremities,
- Fracture of the articular surfaces of all joints,
- Gunshot fractures of the skeleton,
- Open or compound fractures, potentially infected wounds,
- All dislocations.

It will not be forgotten that associated with these fractures there may be contused and lacerated wounds and there may be sprains of joints, distant from the apparent injury. Shock may be present, slight or serious. In addition, damage to muscles, to single nerves or nerve plexuses, to tendons, and to important blood-vessels, may complicate the situation.

There are certain problems necessarily included in this group of injuries which are not altogether settled, viz: (a) the process of repair of fractures, (b) the causes of ununited fractures, (c) the treatment of ununited fractures, (d) the repair of pathological fractures, (e) the proper handling of crushed fractures, (f) the treatment of malunited fractures.

This conception of the surgery of fractures, therefore, is seen to cover pretty completely traumatic surgery. A complete general surgical training and the ability to exercise that sound judgment which comes with experience is obviously necessary for the man who is to handle well the many difficult situations which may arise in any case. The task is a large one.

* Read before the American Surgical Association, June 14, 1921.

Fractures of the Long Bones—*The older methods* (rigid bone methods) of treating fractures By “setting” the fractured bone, by the use of splints and plaster of Paris for fixing the “set bones”, by holding the joints immobilized above and below the fracture, by keeping tightly constricting and compressing splints and bandages on the fractured limb for weeks, the soft parts, the skin, nerves, vessels, and muscles all being left without care—these methods are abominable and should not be tolerated to-day Good results under this ancient régime did occur—often obtained in spite of treatment, not because of it

The principles underlying present methods of handling fractures of the long bones

The French massage treatment advocated, practised, and taught in cases of fracture by Lucas Championnière and his pupils, notably Mennell in London

The extension and counter-extension method advocated by Bardenheuer, of Cologne, and consistently followed by several English surgeons (notably Sir Robert Jones) and by American surgeons Extension and counter-extension thus used requires careful supervision, a nice discrimination in its application, and permits supported active movements of the joints adjacent to the fractured bone at an early date and continuously throughout treatment

The direct bony traction of Codivilla in Italy, of Steinman in Switzerland, of Ransohoff in America, bringing most effectively and accurately the forces of traction and counter-traction into action

The direct grasp of a bone without penetration for the application of traction advocated by Hey-Groves and others

The direct traction methods of Parkhill and Freeman in America

The direct operative treatment advocated and popularized by Sir Arbuthnot Lane and others here and abroad

The suspension of fractures—helping to eliminate muscular contraction and rendering more effective traction forces

The use of the Rontgen ray

All these principles and methods underlying fracture treatment have been recognized for years Recently they have had renewed attention focused upon them by many surgeons because of the dire necessities of war The treatment of war injuries tends to simplicity Consequently many irrelevant forms of apparatus have been eliminated

The war has further influenced the treatment of fractures by simplifying the emergency treatment, by an effective treatment of compound fractures (through the Carrel-Dakin principles), by eliminating certain inefficient traditional methods of treatment, and by emphasizing the possibilities of suspension and direct traction scarcely dreamed of a few years ago

Experience, too, has gradually decreased the instances in which foreign unabsorbable material should be employed The operative treatment is better defined in the selection of suitable cases The selection of the appropriate non-operative treatment in individual cases can be more accurately made The old principles of prolonged fixation of joints adjacent to fractures has

passed The early active motion of joints under protection is employed and is furnishing remarkable results

The results of the treatment of fractures of the long bones to-day are unusual compared with the results under the older methods

General surgeons are as a group uninterested in treating fractures There are, of course, exceptions in every community The attention of the general surgeon has been directed from fractures to the more dramatic fields of abdominal surgery

In general, the collective results of fracture treatment are even now throughout the country deplorably poor The community, every fracture patient, the working man in particular, are all asking for better results The employer of labor is demanding that injured men be gotten back to work more quickly, that fewer hours be lost Great pressure is being brought to bear on the surgeon to secure more satisfactory results The very large number of fracture cases occurring in any community makes the problem important This demand for better functional results in a shorter time is a just demand How shall this demand be met?

My answer is, briefly, the treatment of fractures may be improved—

1 By an organized fracture service in each of the large hospitals of the country, *

(a) Special wards should be used for men, women, and children, and only fracture cases admitted It is impossible to care adequately for these cases when they are scattered throughout the hospital Responsibility is divided among many individuals No concentrated interest results Too much work is delegated to ignorant subordinates The general service would be more free if separated from the fracture cases

(b) A special fracture personnel should be in charge of these fracture wards There should be a Chief of this service, a surgeon of broad general experience, whose interest should be active in moulding the policy of the fracture division The Chief should have absolute control of the policy of the division He alone should be finally responsible for results Serving with and under this Chief should be the necessary assistant surgeons, resident house surgeons, and a nursing force The service should be continuous throughout the year

(c) This continuous control should include the Out-Patient Service, where the ambulatory cases are received and treated Each day of the week there should be an Out-Patient clinic for fractures, which the Fracture Service controls and with which it is in intimate touch The

* For a number of years there has been at the Massachusetts General Hospital, an organized Fracture Service This is among the earliest, if not the first Fracture Service established in a general hospital

PROBLEMS CONCERNING FRACTURES

policies of the Out-Patient and House Fracture Services should be identical under the Chief of the service. Cases of fracture should be followed until the maximum functional results are obtained, and until the wage earner is on his feet and reestablished.

(d) The emergency ward or accident service, in so far as fractures are concerned, should likewise be under the direct care of the Chief of the Fracture Service. A fracture received into the accident ward should be regarded as an emergency case requiring the immediate attention of those directly responsible for the ultimate result. A fracture should be considered as much an emergency as is a case of perforated gastric ulcer. The initial treatment is vital to a satisfactory outcome in both instances.

(e) An operating plant in connection with the House Service is essential. The operative fractures must be kept apart from septic operations. Separate instruments must be employed.

(f) A lecture room with easy access to the wards is necessary.

2 By adequate instruction of the undergraduate medical student. The student should have a definite concept of a fracture of bone—what it looks like, what it is, the changes taking place in the tissues involved, the processes of repair. All these conditions should be accurately visualized by the student. Then the principles underlying the treatment of a fracture will be more intelligently grasped, based upon known and familiar anatomical, physiological, and pathological facts. The undergraduate should be carried only a short distance in fracture instruction and only with illustrative cases.

Unfortunately, undergraduate medical students are overtaught today. The curriculum is crowded. The special branches should be taken from the routine curriculum and instruction limited more closely to general principles. This instruction in fractures should come in the third and fourth years. The medical school is the place to look for fundamental improvement in fracture treatment. Let us study to improve methods of elementary and graduate instruction in fractures. Good results are then bound to follow.

3 By instituting smaller hospital units in towns adjacent to and remote from large centres. An educational propaganda should be started which would result in a suitable fracture equipment being installed in each hospital. Such an equipment would afford opportunity for the instruction of certain interested physicians or surgeons of the community in the use of this equipment in actual cases of fracture. This educational propaganda might well be undertaken by individual surgeons of a large centre as definite educational missionary work.

4 By the graduate instruction of the general practitioner interested in fractures. The graduate medical school courses can readily supply this need. The details of treatment can here be covered very thoroughly.

5 Through the formal instruction of medical students intending to specialize in this branch of surgery. The infinite details of treatment

should not be taught to undergraduates, but should be taught the special undergraduate student in the graduate school courses

6 By encouraging the specialization within general surgery of the surgery of fractures Traumatic surgery to-day covers a complicated and varied field I believe there is ample scope for such a specialty

There will always be physicians in the community who will want to do everything, but there will also be some wishing to excel in a special field

The establishing of a specialty of fracture surgery or of traumatic surgery in our larger centres should conduce to (a) better service to the community and (b) a more rapid advance in the knowledge of the treatment of special fractures

At present in a large hospital it may be more practical for the neurological surgeon to care for head injuries and spinal injuries, for the thoracic surgeon to care for the pneumothorax following penetrating lung fractures of the ribs, for the genito-urinary surgeon to repair a ruptured bladder after fracture of the pelvis, for the abdominal surgeon to take care of the ruptured intestine in a crush of lower rib or pelvis, but the Chief of the Fracture Service should be a man so trained as to be able to handle any such complication that occurs in his division Thus the special Fracture Service or Traumatic Service would occupy a dignified position along with the other special services

7 By the organization of a Clinical Surgical Fracture Society meeting once a year for the sole discussion of fracture problems The membership in such an organization should be carefully safeguarded

Therefore, as Hey-Groves has put it, "by segregation of cases, continuity of service, and team work," by the properly organized instruction of the young men of the medical schools of the country working through special fracture services, by educational propaganda among the smaller towns, by carefully arranged graduate school instruction of medical practitioners, an influence may be gradually exerted which will eventually bring the results of fracture treatment to a high level, save dollars to the laboring man, save time to industry, and further the scientific investigation of problems connected with bone repair

One query has grown out of this world war which is a very pertinent one and so widespread that it must be mentioned and answered Orthopædic surgeons did splendid work during the late war Only admiration is had for their early and complete organization, only praise for all they helped accomplish Returning from the traumatic surgery of the war to civil life, the question is being forced upon surgical staffs of hospitals all over the United States and Canada Shall fractures of bone and traumatic surgery as outlined above be delegated in the first instance to members of the orthopædic staff of our hospitals?

General practitioners of medicine must, of course, always take care of fractures to a greater or less extent, especially in rural communities Such men should have opportunities to become familiar with good methods, espe-

cially of first treatment afforded by graduate school courses. The general practitioner always has at hand some surgeon in a smaller or larger centre who should be competent in this kind of case. To him he will defer doubtful matters about any case. Fractures, traumatic surgery, should always remain a part of general surgery. No one should assume the care of fractures who is not fitted to meet properly the very serious complications, sequelæ, and attendant emergencies of fracture treatment.

Unfortunately, many good men are in orthopædic work who are not qualified as general surgeons. The opposition, I take it, that obtains on the part of the general surgeon to orthopædic men being assigned to the care of fractures rests solely upon the fact of their lack of general surgical experience. If in any community *competent* orthopædic men exist, of course they may properly be given the care of fractures.

My personal feeling is that the working out of this problem is to be a long and tedious one. We all want to see fractures and traumatic surgery better cared for. If the ground taken by the President of the American Orthopædic Association in his presidential address this year is realized, viz., "a most complete early training in general surgery of all those who would become orthopædic surgeons," then an improvement will have been made in one direction. The door to any special surgical work should be always through general surgery. Unfortunately many begin special work by short cuts which may definitely leave the stamp of narrowness and inefficiency upon the individual and his work.

Let the valuable special orthopædic training be conserved for the Fracture Service. Let us not make the mistake of immediately placing orthopædic men (yet untrained surgeons) at the head of special fracture services. Let us rather make the competent orthopædic men consultants to such fracture services under the present leadership of a Chief of Service—a general surgeon acutely skilled and interested in fractures and traumatic surgery. We then will preserve the proper relationship between the specialty of Traumatic Surgery or Fracture Surgery and General Surgery, and we shall gradually enrich this specialty by the brains of men interested in mechanical problems *per se*.

The time is coming when young men of this country will specialize in Traumatic Surgery. They will not be orthopædic surgeons doing traumatic surgery. They will be primarily Surgeons of Traumatism. The present scope of orthopædic surgery is sufficiently large to occupy the orthopædic surgeon. There are ample reasons for a definite specialty in Traumatic Surgery as outlined above.

THE VALUES OF THE VARIOUS METHODS OF BONE GRAFTINGS JUDGED BY 1390 REPORTED CASES*

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SURGEONS have been experimenting with bone graftings, and a sufficient number of the various methods have been performed to form a basis of their comparative values. All graftings reported in the literature, together with the results obtained from a questionnaire, have been analyzed*. In these tables, methods are considered successful only when grafts have produced a satisfactory amount of new bone. Valuable conclusions can only be drawn from the results obtained by the employment of human bone, experiments in dogs being of little or no value in demonstrating either the best method of grafting or the reasons for the success or failure of the method employed. In dogs it is impossible to produce non-union of a fracture, except by interposing soft tissues. In the human, non-union of a fracture frequently occurs, and, while many are due to faulty treatment, a considerable number cannot be explained on any known hypothesis.

It seems true, with the possible exception of a few cells on the surface of a bone graft which are not cut off from their blood supply, that all the adult bone-cells in the interior of a bony transplant necessarily die because of their being cut off from their nutrient supply—that they never proliferate a new bone-cell. If this be correct, the objection to the use of the electric motor saw, on the ground that the generated heat kills the bone-cells, has no weight. The practical results of bone graftings show that there is little difference in the final success or failure of a bone graft whether it is made by a motor saw or a chisel. Too much importance has been placed upon the bone-cell as the essential element in bone regeneration, and this error has obscured a right conception of the process. Bancroft says "Bone is mesoblastic in origin, and in its repair we find that calcium salts are deposited on the intracellular elements of connective tissue, forming new bone. The connective-tissue cell, then, by a process of metaplasia, becomes a bone-cell. Periosteum is a connective tissue and hence is prone to form bone, but it is not the *only* connective tissue that has this function." Neuhoﬀ has performed some interesting as well as astonishing experiments in dogs. He transplanted fascia lata into defects made in the bladder, ureteral, and stomach walls, to see how connective tissue would act when introduced into these localities. To his astonishment, bone was formed in the fascial (*i e*, connective tissue) transplants in each of these three positions—that is, in a position where the transplants were each bathed in an acid fluid.

Since the tendency to the formation of connective tissue is universally

* Read before the American Surgical Association, June 14, 1921

¹ Exclusive of Albee's statistics which are not available

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present in the tissues, it seems reasonable to argue that there must be some peculiar chemical influence present in a particular location to cause the precipitation or deposition of calcium in connective tissue, in order to start the formation of bone. That acidity is not necessarily the determining factor in new bone formation, seems to be demonstrated in the formation of new bone in extraskeletal tissues, such as arteries, ovaries, kidneys, myositis ossificans, etc., where the alkaline blood bathes the tissues. Some chemical combination in the blood, in association with some local stimulus, rather than the reaction of the blood, seems necessary to form new bone in connective tissue. Perhaps some day the physiological chemist will discover some substance to inject into connective tissue which will precipitate calcium and start the process of forming new bone.

Connective tissue seems to be essential in the formation of bone. Osteoblasts are indistinguishable from fibroblasts. The first occurrence in bone formation is the arranging of fibroblasts (osteoblasts) around a blood-vessel. In this new fibrous tissue, calcium is deposited by some unknown influence, which goes on to the formation of bone. If calcium is deficient, fibrous union results, due to some chemical deficiency. If there is too much mobility between the fragments, there is a stage of cartilage formation which may eventually become changed into bone. Where there is no mobility, as in the fracture of one bone with a parallel bone acting as a splint, there is no formation of cartilage.

There are three requirements of a successful bone graft

- 1 It must bridge a defect
 - 2 It must be of a size and type to reestablish the circulation
 - 3 It must act as a stimulus to osteogenesis
- Raw living bone is a very powerful stimulus to osteogenesis. The osteoperitoneal method offers a very large area of raw bone, hence is to be preferred to all other methods of grafting.

There is much in osteogenesis that is still unknown, namely, the chemistry and the physiology of the process. Why is it that sometimes a bone graft, which has remained in place without suppuration, will gradually melt away in the tissues, will become gradually absorbed, and its place not be taken by new bone? This is one of the most disappointing results of a well-conceived and well-carried out bone-grafting procedure that can happen, and it has occurred to all of us. It makes no difference what method is employed in grafting, it occurs in all methods, whether the periosteum is on the graft or not.

RESULTS OF REPORTED METHODS OF BONE GRAFTING

TABLE I

Combined Statistics

Total Number of Cases, 1390 Successes, 1145, or 82.3 per cent Failures, 245, or 17.6 per cent With Periosteum, 1170 Successes, 970, or 82.9 per cent Failures, 200, or 17.1 per cent Without Periosteum, 196 Successes, 162, or 82.6

per cent Failures, 34, or 17.4 per cent Suppuration in 121 cases, or 8 per cent, Successes, 32 per cent Failures, 68 per cent

TABLE II

Methods

- 1 Bone pegs, 24 Successes, 23, or 95.8 per cent Failures, 1, or 4.2 per cent
- 2 Osteoperiosteal, 426 (Ollier, Codivilla, Delageniere) Successes, 372, or 87.3 per cent Failures, 54, or 12.7 per cent
- 3 End-to-end (without inlaying), 166 Successes, 137, or 82.5 per cent Failures, 29, or 17.5 per cent With periosteum, 74 Successes, 54, or 72.9 per cent Failures, 20, or 27.1 per cent Without periosteum, 92 Successes, 83, or 90.2 per cent Failures, 9, or 9.8 per cent
- 4 Inlay, 540 Successes, 437, or 80.9 per cent Failures, 103, or 19.1 per cent With periosteum, 494 Successes, 396, or 80.1 per cent Failures, 98, or 19.9 per cent Without Periosteum, 46, Success, 41, or 89.1 per cent Failures 5, or 10.9 per cent
- 5 Intramedullary (Murphy), 214 Successes, 164, or 76.6 per cent Failures, 50, or 23.3 per cent With Periosteum, 140 Successes, 117, or 83.5 per cent Failures, 23, or 16.5 per cent Without Periosteum, 64 Successes, 45, or 70.3 per cent Failures, 19, or 29.7 per cent
- 6 Combined Intramedullar (one end) with Inlay (other end), 20 Successes, 12, or 60 per cent Failures, 8, or 40 per cent

Table I shows a total of 1390 patients upon whom bone graftings were performed, and of these 1145, or 82.3 per cent, succeeded, while 245, or 17.6 per cent, failed. Successes were the same proportionately whether periosteum was on the graft or not. Analyses of the various methods show that 95.8 per cent of bone pegs were successful, these being, of course, without periosteum or endosteum upon the grafts. The osteoperiosteal method, developed by the French school, particularly Delageniere,* proved the next most successful. This consists in moulding about the fragments strips of periosteum, taken from the tibia, to which adhere thin plaques of bone. Successes by this method were 87.3 per cent. By the end-to-end without inlaying method, favored by the English surgeons, 82.5 per cent of successes were obtained, and by the inlay method, most in favor in America, 80.9 per cent were successful. By the intramedullary method, developed by Murphy, only 76.6 per cent of successes resulted. The intramedullary graft at one end combined with an inlay at the other, with 60 per cent of successes, proved the least successful of all, possibly because of the liability to dislocation of the graft. This would tend to show that the intramedullary method should be discarded as a method of bone grafting.

Further analysis of the effect the presence or absence of the periosteum has upon the results of the various methods of bone grafting shows the following (Table 2)

- 3 End-to-end, With Periosteum Successes, 73 per cent Without Periosteum Successes, 90 per cent
- 4 Inlay, With Periosteum Successes, 80 per cent Without Periosteum Successes, 89 per cent

* Jour de Chir, vol xvii, April, 1921, p 305

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5 Intramedullary, With Periosteum Successes, 83.5 per cent Without Periosteum Successes, 70.3 per cent

Thus, with the end-to-end method there were 18 per cent *fewer* successes and with the inlay there were 9 per cent *fewer* successes with grafts *with* periosteum than *without*, while with the intramedullary method there were 13 per cent *more* successes with grafts *with* periosteum than *without*, so that we must draw the conclusion that in the end-to-end and inlay methods, periosteum on the grafts seems to be slightly disadvantageous, while on the intramedullary grafts it acts more advantageously with than without. Ashhurst has reported 27 inlay bone graftings without periosteum with 22 successes (81.5 per cent), and Gallie, 18 inlays without periosteum, with 100 per cent of successes. It is difficult from these statistics to measure accurately the value of periosteum on grafts. Theoretically, most surgeons believe it of value though not considered essential, it is supposed to assist in establishing a new and richer circulation, upon the extent of which the amount of the formation of new bone seems to depend. Several reasons may be advanced to account for the relatively poor results of intramedullary grafts. Firstly, because of the obliteration of the nutrient artery, from which the graft largely obtains its blood supply, through thrombosis, antecedent trauma or operative procedure. Secondly, because of the liability of dislocation of the graft. Thirdly, because of its susceptibility to fracture. Fourthly, because of the difficulty of adequately immobilizing or anchoring the graft. Fifthly, because, in the opinion of some, of the lack of periosteum. In case of suppuration the success of the transplantation has been deemed more likely *with* periosteum than *without*, for the periosteum is much more resistant to infection than bone. In illustration of this fact, I reported (ANNALS OF SURGERY, 1921) one case of an inlay graft with periosteum, made for a defect in the lower jaw, which suppurred, losing, by sequestration, almost its entire bone content, which eventually proved completely successful through the re-formation of the bony segment, which presumably came from the transplanted periosteum.

Fisher (*Lancet*, April 23, 1921, p. 844) says

"From a study of the pathological appearances in the cases of loose bodies of bone and cartilage quite free in the joint, it is clear that the majority of the bone corpuscles were dead, as exemplified by lacunae no longer holding stainable cells. Furthermore, in not a single case was there any evidence of proliferation of osteoblasts with formation of new bone. Yet we see a striking difference on examining those bodies of traumatic origin and containing bone which have acquired an early adhesion to the synovial membrane. For in these, fresh capillaries can be seen to have penetrated the cancellous spaces, and active proliferation of osteoblasts with formation of new bone is taking place. Exactly the same thing can be observed in the experimental production of loose bodies which show secondary attachment to the synovial membrane with active proliferation of bone cells. These observations therefore support Hey-Grove's contention that the osteogenetic cells in the Haversian canals and cancellous spaces of an autogenous bone-graft actively proliferate only if the graft becomes to some extent vascularized by the ingrowth of capillaries from sur-

rounding parts As, therefore, the vascular supply appears to be of such paramount importance in the osteogenic function of the bone-graft, it would appear to be advantageous to retain the periosteum in order to enable the graft to establish its vascular connections as rapidly as possible"

The part played by periosteum has been considered by Leriche and Policard It seems to them that periosteum has two elements with antagonistic tendencies, but the juxtaposition of these two elements produces a harmony in the process of osteogenesis The element of bone growth is in the cambium layer of the periosteum (*i e*, the juxtaosseous connective tissue) and the adjacent bone, and that which arrests bone formation is the outer fibrous layer of the periosteum Between the two there is normally a state of equilibrium and leads to the entire series of osteogenesis, hence the periosteum is the whole manageable agent of surgical osteogenesis By the stripping up of the periosteum, the cortical layer of the bone regains its power of extension, new bone appears, pushed forward to establish a new state of equilibrium This view seems to be substantiated by the results of subperiosteal resection of bony prominences, in which new bone is formed beneath the periosteum, not outside of it unless the periosteum has been ruptured Renfrew White says The osteogenic properties of the periosteum, which it seems to possess, are, in fact, not its own but due to a resumption of osteoblastic activity of the cells of minute portions of bone that have adhered to it, having been detached with it

Sebleau (*Presse Med*, August 1, 1918) showed a specimen, removed at autopsy ten months after an osteoperiosteal graft, four inches long, taken from the tibia, which had been transplanted to bridge a defect in the lower jaw There was a firm osseous callus between the two stumps, although the outer periosteal surface had been turned, being directly applied to the bone surfaces, reversing the ordinary procedure This seems to show that a graft is endowed with vitality in itself

A study of these results of the various methods of bone grafting shows definitely that the method most likely to achieve success is the osteoperiosteal That this method is applicable in large defects is shown in a case reported by Katzenstein (*Rev de Chir*, May, 1910, p 952), where 13 cm of the diaphysis of the femur were missing He hollowed out, in the end of each fragment, a cavity which received the extremities of the transposed periosteal strip to which were clinging thin plaques of bone of the thickness of a dime Immobilization was maintained for six months, when the defect became filled in with new bone, and the man could walk without support An advantageous amplification of this method would be, after removing the periosteal strips from the tibia, to take bone chips from the raw tibial surface with a gouge and to implant these chips so as to fill in the defect (Macewen) between the ends of the fragments The osteoperiosteal flaps overlap the ends of the fragments to which they are sutured with catgut The advantages of this method include

- 1 Increased liability to success of the grafting
- 2 Greater simplicity of the technic of obtaining the graft, there being no necessity of complicated motor saws
- 3 Decrease in the liability of subsequent fracturing of the tibia from which the graft is taken, of which there are numerous reports in the literature

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Macewen has recorded successes after implanting small bone chips in the human while Bancroft has had successes with the same method. A much better method than to fill a bone cavity with fat after sterilization, is to fill the cavity with a curled-up osteoperiosteal flap. By this procedure the cavity becomes filled with new bone.

CAUSES OF FAILURES OF BONE GRAFTINGS

1 *Improper Method Employed*—From Table 2, it is seen that the osteoperiosteal method is attended with the greatest number of successes, and the intramedullary method with the smallest number. The presence or absence of periosteum seems to be immaterial.

2 *Suppuration*—This is apparently the most evident cause of failures in bone graftings. Walker (ANNALS OF SURGERY, January, 1921, p. 2) reports that in 62 per cent of 46 cases in the army (Surgeon General's Statistics) which suppurated after graftings, the transplants were finally successful. These results are clearly too favorable, because in the author's statistics of 1390 graftings, successes were 82 per cent, hence Walker's statistics show only 20 per cent injuriously affected by suppuration. Of the author's reported 121 cases (8 per cent of all), which suppurated, only 32 per cent were successful.

3 *Immobilization*—Insufficient immobilization, or over too short a period, seems to be a very patent and frequent cause of failures. The most perfect immobilization that can be obtained after graftings should be employed. Brooks has shown that the absorption of bone in a bone graft is not complete before the end of two months. In addition regeneration of bone, as a result of a bone graft, depends primarily upon the blood supply to the graft. These new-formed blood-vessels are very easily ruptured by mobility of the fragments, thus compromising the necessary blood supply to the graft. Hence the suspension method of treating bone grafts in a Balkan frame is contra-indicated as allowing too much mobility between the fragments and the graft. Massage is likewise contra-indicated for the same reason. From four to six months absolute immobilization is the minimum time in which it should be employed, unless careful testing shows consolidation to be complete before this time.

4 *Fracture and Dislocation of the Grafts*—These likewise are often the cause of failures and are frequently due to insufficient immobilization.

5 *Atrophy of the Ends of the Bone Fragments*—No grafting should be undertaken if a radiogram shows the ends of the bones to be markedly atrophied, which is caused by deficient nutrition from too tight or too long prolonged immobilization, suppuration, neurotrophic disturbances, senility, etc. In such cases measures should be taken before grafting is undertaken to stimulate the function and the circulation of the parts by removing all splints, allowing free use of limb, bakings, massage, Bier's hyperæmia, etc.

6 There is no evident explanation of some failures of bone grafting. Despite aseptic healing in of the grafts, a certain proportion of them (17.6 per cent) will fail, indicating some chemical or physiological deficiency, of which we are as yet ignorant. Greater efforts in future must be made along chemical and physiological grounds to discover the elements which initiate new bone formation as well as those which continue the process when once it has started.

CONCLUSIONS

From 1390 bone graftings we find

1 That there were 82.3 per cent of successes with 17.6 per cent of failures

2 In the order of successes, we have,

a With bone pegs, 95.8 per cent were successful

b With the osteoperiosteal method (Delageniere), 87.3 per cent were successful

c With the end-to-end method (without inlaying), 82.5 per cent were successful

d With the inlay method, 80.9 per cent were successful

e With the intramedullary method (Murphy), 76.6 per cent were successful

f With the combined intramedullary (at one end) and the inlay (at the other), 60 per cent were successful

3 The presence or absence of periosteum seems to exert no influence on the success of bone grafts. Proportionately, the percentage of successes without periosteum (82.3 per cent) is the same as with (82.9 per cent). In the end-to-end method, there were 18 per cent more successes than failures without periosteum, and in the inlay method, 9 per cent more successes without periosteum than with, while, on the contrary, with the intramedullary method, there were 13 per cent more successes with grafts *with* periosteum than without. It is difficult to explain the cause of the differences in the various methods.

4 Suppuration occurred in 121 cases, or 8 per cent, 32 per cent of these succeeded. Suppuration is the most frequent cause of non-success of graftings, with insufficient immobilization and too short duration as the second most frequent cause.

5 The conclusion is reached that the most successful method of bone grafting is by the osteoperiosteal method (Delageniere). The bony defect should be filled in with small bone chips, and on one or two aspects, overlapping the ends of the fragments, covering in the bone chips, should be placed one or two strips of periosteum with adherent, osseous plaques, taken from another bone. This method is as applicable to large as to small bony defects.

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6 The cause of many non-successes is due to defective immobilization, or to undue curtailment of its duration From four to six months' immobilization is ordinarily required for complete success

7 There is sufficient evidence to prove that the most effectual treatment of non-union of fractures is bone grafting

8 The causes of failures of bone graftings, summarized, are

a Improper method of grafting

b Suppuration

c Insufficient immobilization, or over too short a period of time

d Fracture and dislocation of the grafts

e Atrophy of the ends of the bone to be grafted

9 The intramedullary method of grafting should be discarded

10 Despite a few opinions to the contrary, bone graftings should not be performed in infected fields

OLD OS CALCIS FRACTURES*

By FRED J COTTON, M D.

OF BOSTON, MASS

OS CALCIS *fractures*, not common, scarcely seen except as the result of industrial accidents, are of interest because they give so large a percentage of cripples and because these cripples are strong men as a rule in youth or vigorous middle age

Years ago ¹ I went into the question of the treatment of the fresh os calcis fractures, basing recommendations on a serious investigation of a long series of old cases at the City Hospital, and on a recognition, by us apparently for the first time, of the essentials of the injury and the real *causes* of disability

Neither in the cases in this paper nor in those of a later one ² nor in the cases collected by the Industrial Accident Board of Massachusetts ³ have we acquired data on which to base any accurate percentage statement of disability

There are, under ordinary treatment, a few cases (without much original displacement) that recover with good or fair feet, these are cases mainly of little displacement, a large proportion, certainly much more than half the total, are partly disabled and handicapped in their work total disability for real work seems to be the fate of something like one-third to one-half the cases

There is, I think, nothing to add to what I have already written as to fresh cases in the above-cited articles and in a book ⁴ on fractures, as to lesions or treatment, save for the addition of later cases Today I should perhaps lay more stress on remodelling, less on "impaction," for I suspect that the impaction resulting is not mechanically first-rate as a rule

This remodelling or impaction method has been adopted by a good many surgeons with good results, I think, as a rule My own cases have been not perfect, of course, but satisfactory, and I think there have been none with serious permanent disability But, while I see fewer fresh cases each year, ⁵ on the other hand I see, of late, more and more a number of the cripples untreated very often diagnosed as sprained ankles in the early weeks These men, disabled, out of work in several instances for a year or two years, have been referred to me by insurers as a rule, with the idea of returning them to industry They have usually been baked and massaged with no benefit (except to the baker), the "bakee," if one may so call him, still limps, and keeps on with his compensation under the accident laws The problem is not new, or easy My earlier attempts were rewarded by improvement, not by cures

I had worked with the idea of clearing away excess bone, on the outer side, removing spurs, and limbering up joints by manipulation

Prince, of Rochester, N Y, had done arthrodesis of the posterior calcaneo-

* Read before the American Surgical Association, June 14, 1921

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astragaloid joint to relieve strain No one else seems to have done anything in particular

In the last two years I have been beginning to get real results—good enough to feel that we have something approaching a solution of the problem Wherefore, this paper was prepared

The cases run curiously similar as a rule in their main features In the

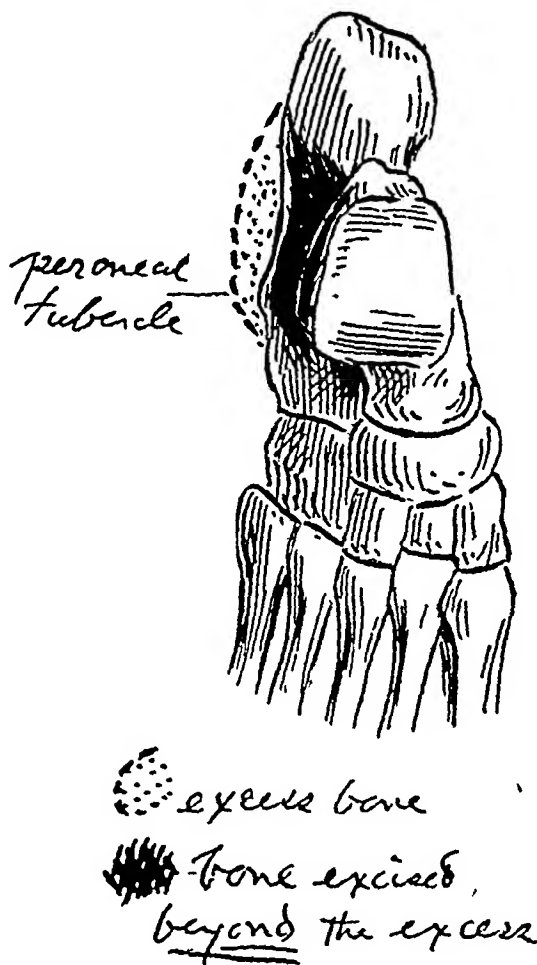


FIG 1

first place, they all have the calcis a little short from front to back, a bit flattened, often more than a bit, on the sole Beyond a little loss of "spring," this shortening seems to make little difference Rarely there is sharp *outward deviation* of the whole heel This entails inevitable flat-foot, not to be relieved by supports The deformity must be corrected by the Gleich operation, of which more later

Third Spurs on the plantar face of the calcis are not uncommon If tender, as they usually are, they must come out

Fourth In every crippled case that I have seen, the outward broadening due to the shoving outward of the peroneal plate of bone and to bone-growth behind it, has been a source of trouble Sometimes the external malleolus hits the exuberant bone or is half buried in it sometimes it hits only in extension

or only in flexion sometimes it merely pinches the peroneal tendons and their sheath, but, invariably it is a factor in the pain and disability^a

How considerable this mass often is will be seen from some of the X-rays taken from above and behind—a rather useful even if an unusual view

Fifth The loss of some part of the lateral motion is constant, loss of *all* lateral motion not rare As a rule, this limited motion is, at its limits, painful, and is always a bit disabling because of resultant clumsiness This loss of motion results from what we may call clogging of the posterior calcaneo-astragaloid joint either from fracture across it or from fracture displacing the unbroken joint-surfaces or shortening the slide, or from new bone heaped up roundabout the malleolus or in front Practically all motions of the foot laterally, remember, depend on free motion in the two joints on the under surface of the astragalus, both joints articulating with the os calcis With

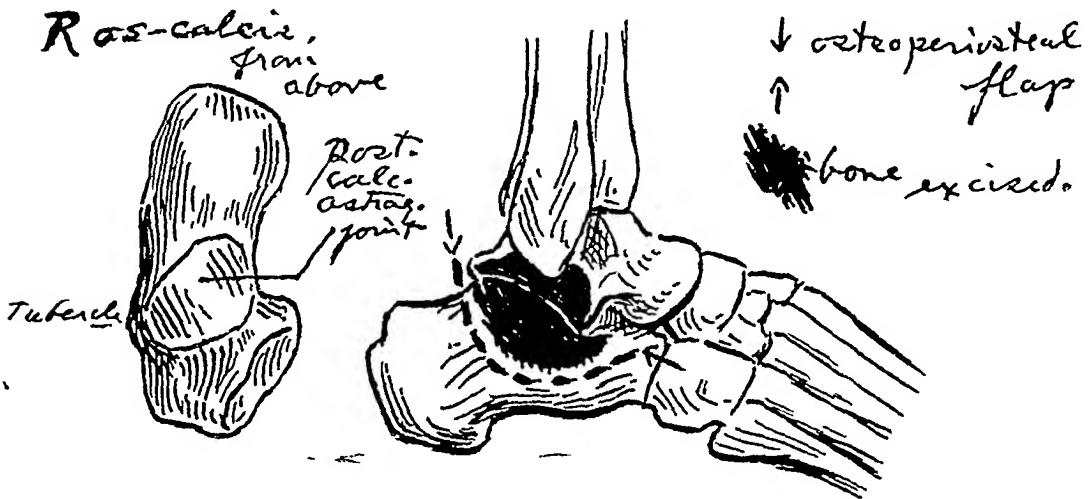


FIG 2

even only the posterior joint locked, the lateral mobility of the foot is gone

Now, as to the repair of these various "proximate causes of disability"

First Shortened and flattened heel, not to be touched, save when combined with outward displacement *Second* Outward deviation, calls for the "Gleich" operation, an operation devised for the cure of flat-foot—a cross-section of the calcis done behind the posterior joint of the os calcis with the astragalus The original description specified a Gigli saw—I have preferred a thin chisel, cutting on a slant slightly down and forward, forward and inward The calcis so cut, it is then easy to displace the heel as one will—with ragged chiselled surfaces, no other fixation than the plaster is needed This operation I have done twice, it is a perfectly simple and straightforward manœuvre *Third* Spurs, sometimes they are spurs of an original fragment, sometimes perhaps newly grown They are to be removed, just like the common osteophytic spurs, through an incision at the side, well above the thick skin of the heel, and they are to be removed very liberally, as are *all* os calcis spurs *Fourth* and *Fifth* These are in fact *one* problem The

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fracture is a crushing fracture with irregular cleavage lines. The result of the usual treatment advocated, which is by way of being no treatment at all, is the formation of a broad, shapeless bone, which has lost all chance of rocking under the astragalus, which has spread so far out and up under the outer malleolus as to give crippling pain from bone contact beside the loss of motion. The failure of a good many attempts to remedy this, including my own earlier efforts, was due to our failure to appreciate the mass of this bone growth, and its great total bulk, and to take account of the fact, well enough known really, that the tarsal bones repair their injuries with unusually

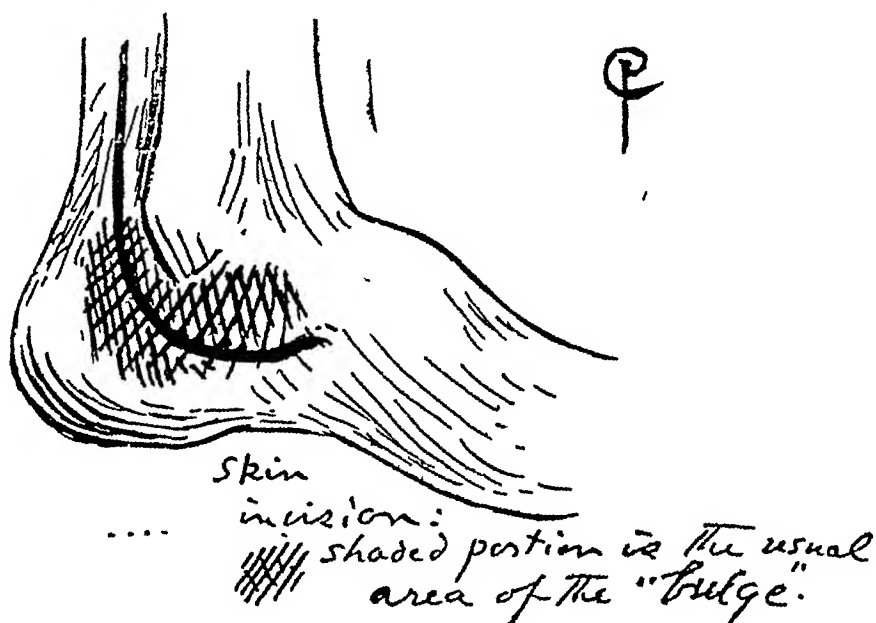


FIG 3

massive bone replacement.⁷ One must do far more than at first seems reasonable.

The key to this whole question is the doing of *enough* surgery. It is like the man who "shaves a day ahead", one must do much more than to remove the presenting excess of bone. Latterly, I have doubled the bone removed, have dug out deep and wide under the peroneal tendons, and then laid them back under pressure. More than that, I have cut ruthlessly *across the joint line* between astragalus and calcis, often leaving what seems not half the joint.

The operation, as developed, is a skin incision, curved down and forward beneath the external malleolus—a stripping up and laying forward and upward of a flap, including the peroneal tendons in their sheath, turning up with them the periosteum and with it the cortical layer of bone, then comes a thorough clearing away of all the excess bone, deep below the cortical level, leaving a saucer-line crater of bone. In doing this clearing away one cuts *across* the posterior astragalo-calcaneal joint regardless of ligaments and of joint capsule. (See Fig 2.) Then, forced manipulation in rotation and in abduction and adduction of the foot complete the clearing of any obstacle to

motion from bone, from adhesions or from scar. At this stage, after reduction, motion should be near normal and unimpeded by adhesions or by excess bone. After the clearing away of excess bone the periosteal bone flap, carrying the tendons, is laid down into the crater from which the discarded bone was removed. Loose suturing completes the open operation.

Plaster is applied in neutral position, and without regard for right-angled flexion. One has never to fear loss of ankle-joint motion in these cases, it simply does not happen, and I have long preferred a position of moderate plantar flexion to the alternative of tenotomy of the T. Achilles, which not uncommonly leads to a rather long-continued atrophy of the calf muscles.⁸

Pressure from outside is applied to the case to keep the deep flap in place under the malleolus in the crater provided by the operation. After two weeks the plaster is cut and guarded motion is begun.

After four weeks one may allow a little weight bearing—cautiously, and motion is emphasized.

At six weeks weight-bearing is allowed, still with some caution, gradually increasing the weight borne, steadily emphasizing the regaining of motion by voluntary exercise, aided by stretching in the hands of the masseuse in case of the laggards.

In the less likely cases arch plates are used, temporarily—either of the usual type, or of the “rocker” plate (the “Whitman” sort)—worn until the foot comes back to useful function.

For the cases so treated, one may claim actually normal function in one, approximately normal, one may say practically normal in six more of the total of nine operated on.⁷ One case, an elderly man, not robust, still has some arthritis tenderness, mainly of the front part of the foot, that interferes a bit with his work.

One case I write down a failure—probably because no one here understands Russian, and he speaks only Russian of some sort. Therefore the routine of exercises could not be impressed on him effectively. Perhaps we mistook his smile for comprehension. I suspect he, too, will later return to work, but for the moment he is written down a failure. The others are cured. Of the two treated as fresh lesions, both are at work, near normal in function. Three, not operated on, have come back to near normal under persistent treatment. Two are too recent to report on.

The case records follow

CASE I—T. McN, aged thirty-six. Carpenter's helper.

Accident. October 24, 1917, fell squarely on both feet. Eleven weeks in bed. One month on crutches, then two canes, able to walk without canes about March, 1918. Referred by London Guarantee and Accident Company, Limited (Figs 2 and 3).

Pain and weakness about ankle of right foot. Marked disability.

Left foot showed on examination by F. J. C., June 10, 1919, a “rigid flat-foot” not of extreme degree, nothing else.

Right foot showed “very evident os calcis fracture with marked thickening below the external malleolus, with definite broadening of the heel seen from be-

hind with a spur on *both* sides so large as to be easily felt with the fingers The foot not much flattened and the heel is *not* turned outward No lateral motion Fair ankle motion" This man has had a fracture of the right os calcis with marked spur projection into the sole This is the tender point. There is also some tenderness below the outer malleolus and some soreness running down the foot from this point No swelling The general condition and ability to use this foot have become, under much massage, much better than one would expect from such findings

Operation proposed to clear the spur and to remove excess bone on the outer side

It is worth noting that an astragalectomy operation had been advised on this case less than a month before I saw him One is at a loss to see how an astragalectomy could help, certainly it would cripple! I have yet to see a really good working result after astragalectomy—and I have seen not a few

June 3, 1919, the usual operation was done, including also in this case the removal of a sharp spur (See Fig 3)

Convalescence was as usual, but slow, which is hardly unusual It was necessary to fuss with a plate for a time, with anterior arch pads also²⁹ He also complained of toe-contractions for a time

Some time (I have not the date) early in 1920, he went back to and has stayed back at work, with serviceable recovery Disability before operation one year eight months After operation, under nine months

Moreover, this result was impeded a bit by the spastic flat-foot on the other side—treated, but yielding to treatment slowly

The foot operated on showed the usual return of well over half the lateral mobility There was entire, though slow, cure of the sensitiveness from spur pressure

CASE II—T McN, aged thirty-three Lineman

May 25, 1918, fell fifteen feet, landing on left heel Other foot unhurt No ether for reduction or pseudoreduction "Cast" for seven weeks Crutches up to about June, 1919 Referred by the London Guarantee and Accident Company, Limited

Seen by F J C, August 6, 1919 Previous to this I had had sent to me plates of both his feet, showing, besides the deformity in one, an appalling "traumatic arthritis" picture of osteoporosis in both feet Examination of the feet themselves, not hot or tender or swollen or spastic, made it evident that this was a result not of an essential arthritic process, but of the fifteen months of utter disuse Examination showed on the right only an old flat-foot, strained from having more than its share of labor imposed on it

"The left foot, on the other hand, shows a condition which I think will have to be remedied by operation The os calcis has been fractured and there has been marked displacement of the back portion of the bone (which includes the bearing surface of the heel) outward rather than upward The flattening of the foot by bone displacement is less than usual, the thickening of the foot no more than average in these cases, but this outward displacement is very extreme and I think without question that it is too great to be remedied effectively without an operation"

The operation proposed was the Gleich operation, namely, a section of the astragalus behind the inner vessels and tendons, down and in, forward and inward

This was done October 27, 1919, and with the Gleich operation the excess bone below the external malleolus was removed in the usual fashion (Fig 4) He was in the hospital for just a month There was the usual slow recovery and gradually increasing use At about a year⁹ he went back to work, and, according to a friend he referred to me lately, is still at work

Disability, original, before operation, seventeen months After operation, not quite a year Result almost 100 per cent

CASE III—W T, aged twenty-one years Sprinkler fitter's helper

On November 14, 1918, fell forty feet Treated at City Hospital, and about January, 1919, came under treatment of Dr A. T Cornwall Seen by F J C, May 26, 1919, for the Accident Board Reported as a result better than usual, but with broadening and much thickening of bone on the outer side Lateral motion much better than usual, but some pain on the outer side in even moderate pronation Trouble only occasionally, but it involves an uncertainty that bars him from liability to accident. Sent by the U S Casualty Company for operation

Operation August, 1919 The usual operation He did well, but slowly Motion excellent and no longer any 'catching' on the outer side He was fitted to a plate with relief and complained only of occasional pain down the outer side of the foot The foot is practically normal in appearance and nearly normal in motion He worked a month in the fall of 1921 Later complained of contracted "hammer toes" and was given treatment to stretch them Redischarged as practically normal in February, 1921

This is in fact a perfectly good cure Personal disinclination and an unfavorable labor market just now are the key to the persistent disability

CASE IV—A F G, aged forty-one

Accident July 21, 1919 Fracture R os calcis, treatment persisted in without much improvement Seen by F J C, May 21, 1920, referred by the U S. Mutual Liability Insurance Company He showed the usual picture with total loss of lateral mobility, with much pain from apparent contact of malleolus and calcis—and also—unusual inability to come up on his toes because of contact of the malleolus with a mass of thickened bone far back (Fig 6)

He was particularly annoyed because as sole survivor of a gun-squad of the Cameronian Highlanders, and shot-up at that, he felt it beneath his dignity to succumb to so unexciting a lesion

Operation June 1, 1920 The usual operation but with a very liberal removal of bone In hospital twelve days Plates and massage as usual Last seen September 23, 1920, at which time there was still some broadening but almost full mobility He then demonstrated his ability to jump up in air and crack his heels together twice—not equal to his previous normal of three times, but fair enough He then went back on his job, and so far as I know is still there

CASE V—F McJ Accident September 9, 1919 Fell thirty to forty feet on his heels City Hospital Plaster six weeks, later electrical treatment with Dr Frank Gardner Report of examination April 23, 1920, showed typical condition, thickening pain on standing or walking, etc Further treatment instituted Seen by F J C Referred by Maryland Casualty Company Usual flattening, broadening, thickening to the outer side, loss of most of the lateral motion (Fig 7)

Operation September 27, 1920 Treatment and recovery as usual

Improved rather quickly but showed some tendency to pronate, relieved by plates and by juggling the shoes Last seen April, 1921 No evidence of disability at all, though lateral motion not to full normal limits

CASE VI—B O, window washer Accident November 8, 1919 Fell two stories Referred by Dr Frank Gardner for the Maryland Casualty Company Seen by F J C, August 20, 1920 Showed clear evidence of double os calcis fracture with little displacement, not much thickening, and good motion on the right

On the left extreme thickening "choking up" against the fibula, not only laterally, but also at the front, with almost no lateral motion Disability to correspond

Operation August 30, 1920 Usual technic Hospital one month, no sepsis,



FIG. 4.—Case I. (From above and behind). Huge broadening of heel with the peroneal plate shoved up squarely against the external malleolus. White dotted line shows roughly the amount of bone removed at operation.

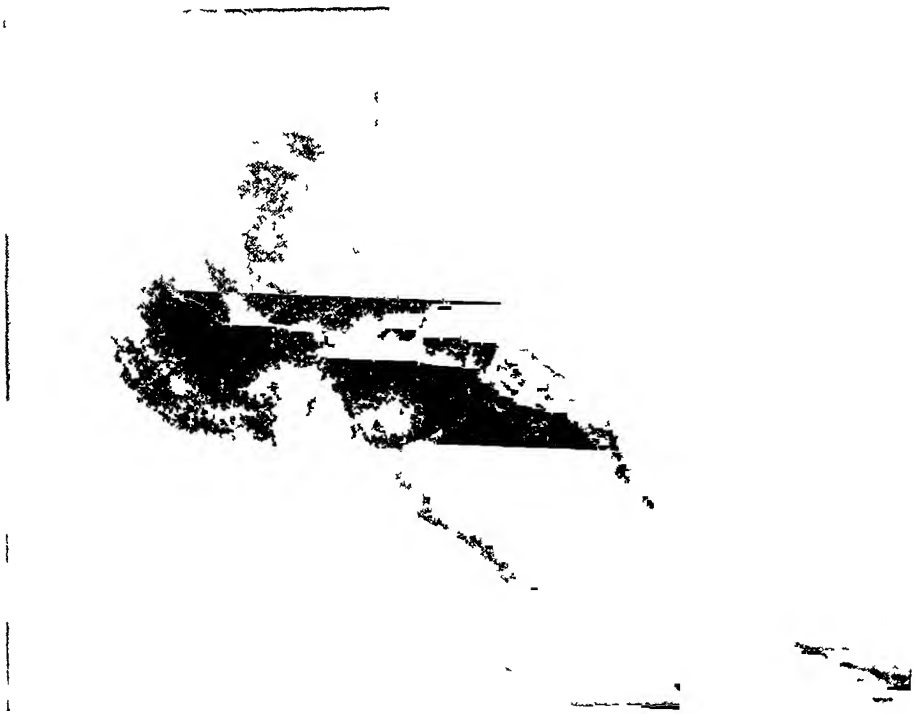


FIG 5 —Case VII Flattened heel Thickening obvious at X Spur on plantar surface from projecting fragment

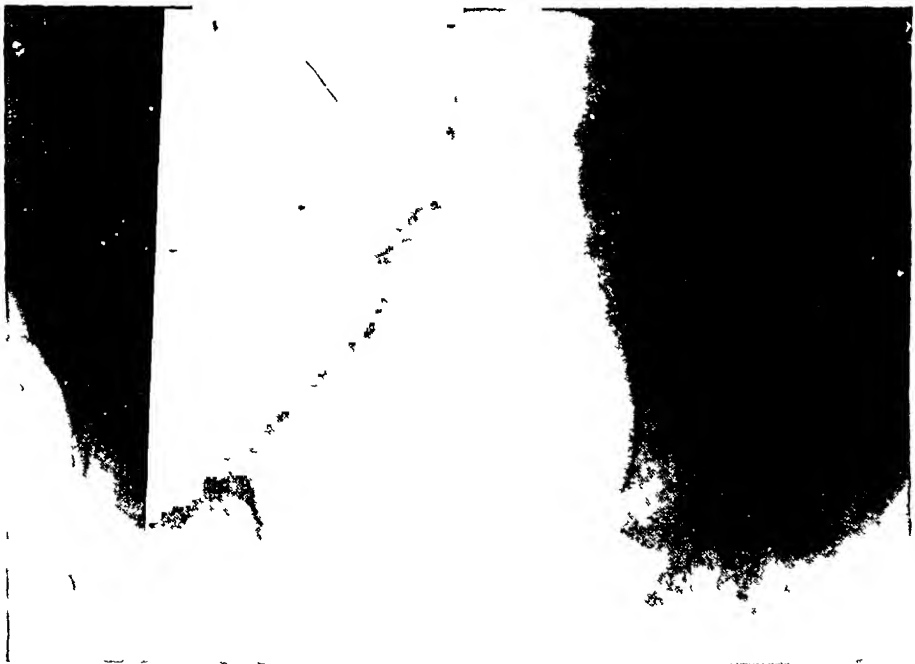


FIG 6 —Case II Fifty two days after a Gleich operation Heel now properly under the foot Still much thickening despite considerable removal of bone Here as always tarsal bone repairs in excess

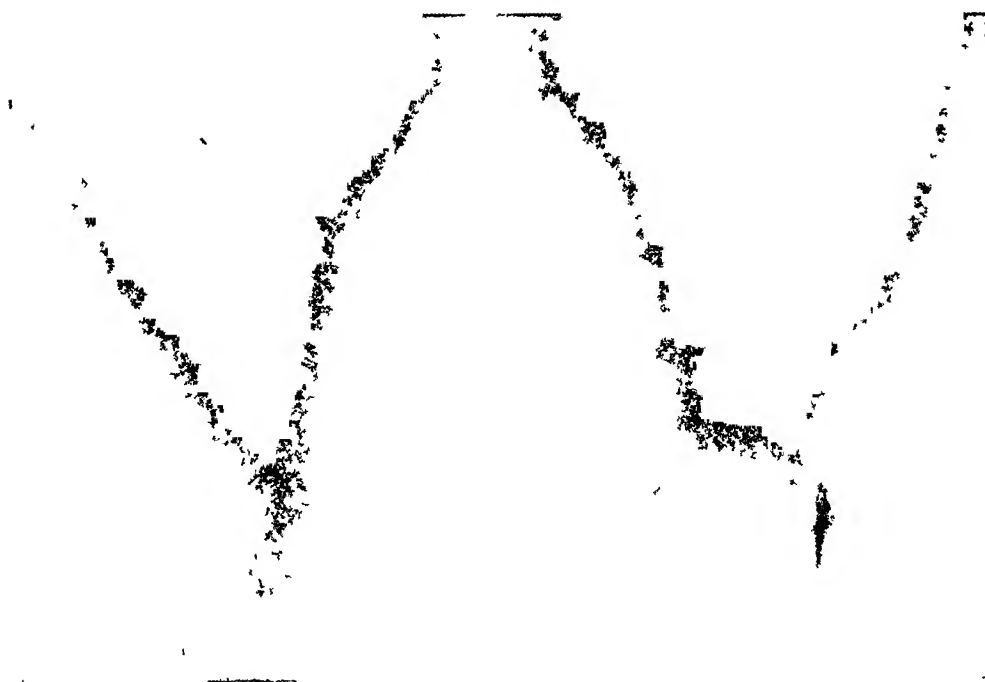


FIG 7—Case IV Right heel shortened, not much outward thickening Main disability here was loss of lateral motion—restored by operation

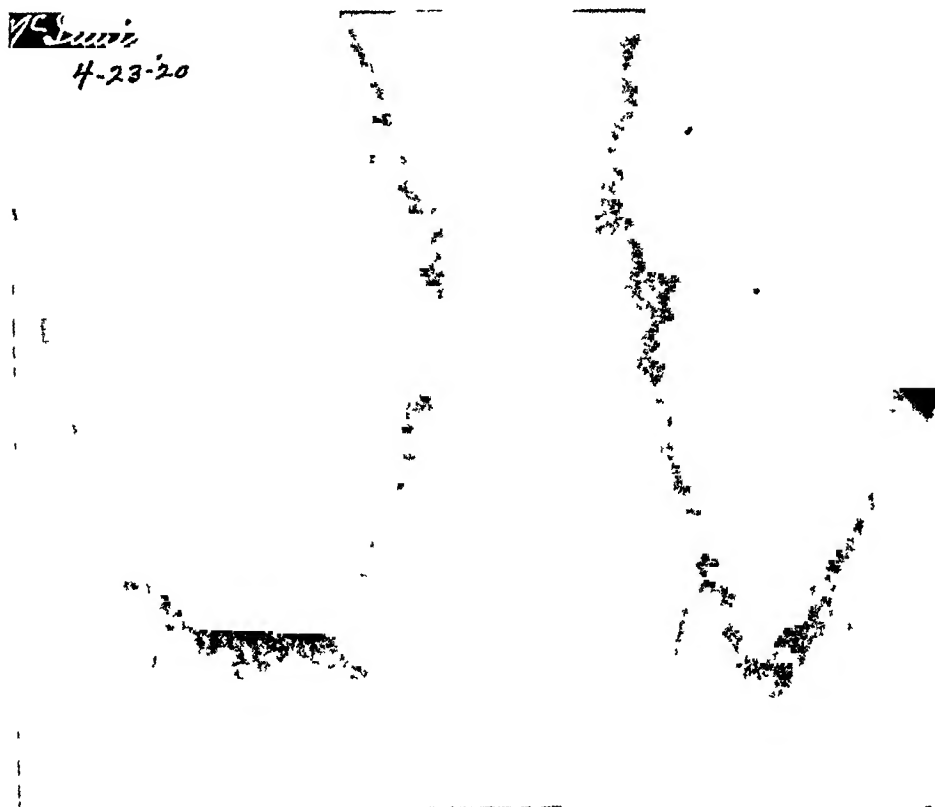


FIG 8—Case V Left os calcis broadened, outer plate displaced far outward

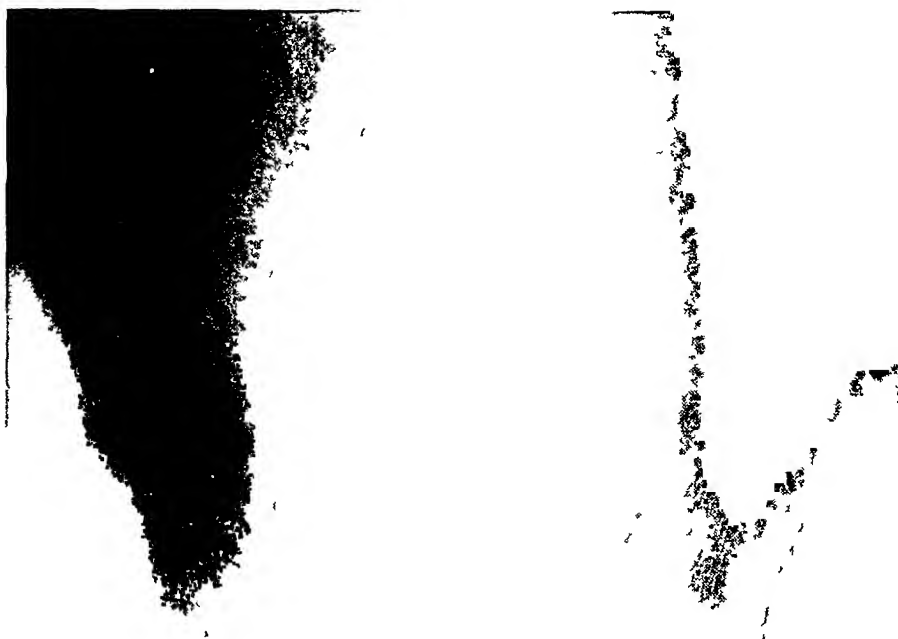


FIG 9 --Case VII Much broadening excessive thickening below external malleolus
Marked osteoporosis



FIG 10 --Case IX. Moderate deformity only. The spur on the inner tuberosity is real and corresponds with the tender point in the sole but is a new growth and not the usual spur from projection of a fragment as seen for instance in FIG 3

but the serous leakage (almost always present for a week or ten days in these cases) persisted a bit longer in this instance, perhaps because an unusual amount of excess bone was removed

Returned to Doctor Gardner's care Recovery very satisfactory, and final function, March, 1921, practically normal as to shape and motion No complaint save of occasional pain on outer side of foot running forward to the last two toes²² Seen June 13, 1921, still has some discomfort, particularly in rising on toes, and is the first case I have seen with limited dorsal flexion Supination about half, other motions normal

CASE VII—D P Seen by F J C, August 13, 1920 Man of fifty-six, not of vigorous type Injury four months previous, fell fifteen feet Referred by Dr S P Strickland, of Waltham, Mass, for the Federal Mutual Liability Insurance Company

Showed fracture of left os calcis with lateral motion entirely gone, crippling pain to the outer side on walking, enormous thickening to the outer side, confirmed by taking X-rays from behind and above (See Fig 7) The X-ray showed less osteoporosis than the case-history, suggested, but did show a discomforting degree of arteriosclerosis of the vessels about the ankle Operation advised, nevertheless

Operation, August 24, 1920 Result September 17th, entire removal of the conspicuous deformity, no swelling, slight tenderness, already about one-third normal motion Later there were arthritic symptoms and static troubles with the anterior arch, etc He started in at work the first of the year 1921, overworked a bit, and, despite shoeing and a plate, still has a foot that tires and swells a little and does not allow him full working time, but he has his motion, and no part of the symptoms (except a bit of nerve pain as in Case III) are at all referable to the region of the os calcis They are anterior arch pains, and swelling of the whole leg on standing, due to a circulation not young and none too good

CASE VIII—H K, May 26, 1919, fell forty to fifty feet, and broke his back (compression fracture first lumbar, without cord-lesions, and practically without nerve-root symptoms) Also he broke his right foot, but the diagnosis of Pott's fracture was made

Accordingly he was sent in by the U S Mutual Liability Insurance Company Examined by F J C, on July 27, 1920, the treated back was nearly well The untreated foot showed a typical os calcis fracture with the usual total loss of lateral motion with lameness on the outer side, with massive bone-thickening beneath the external malleolus, and with tenderness in the sole as well, due to spur points projecting downward

Operation July 30, 1920 Usual technic with removal of much bone at the side and of a spur also, projecting down into the sole toward the inner side He did very well indeed for a time, during his month in hospital, after this less well, owing in part to his being a Russian, speaking an unattainable language, unable to understand very clearly about exercise and use

This case lost his lateral motion to a considerable extent, and when last seen in November, 1920, while he was much better than before operation, with less pain and more motion, he was not fit for heavy labor Not all this unfitness was due to the ankle, the back also had to be reckoned with, but the result of the os calcis operation in this case was less happy than in the others

The operation worked well enough, the after-treatment didn't quite work out

CASE IX—P S Examination April 28, 1921, for the Federal Mutual Liability Insurance Company A year ago, June 11, 1920, he fell and fractured os calcis right and left Has been under treatment, plates, etc Has almost no limp, and on detailed inspection little save moderate thickening on the left On

the right there is more thickening and there is pain when he tries to come up on his toes, apparently from contact of the thickened bone with the external malleolus. The bone thickening toward the back is unusually heavy. Also there is a tender point below the internal tuberosity of the calcis.

There is little tendency to pronation on either side and motion both right and left is good—perhaps one-third normal (Fig 9).

This case looks well enough, but, apparently owing to the bony thickening on the left side, he has been in the discard, industrially for over a year. The X-ray shows only moderate deformity.

He is to be operated on in the near future.

CASE X—H C, aged thirty-four. Painter. Broke heel two years ago in fall from staging. Has gone on under more or less treatment without essential change. He has the usual thickening, lateral motion not over a quarter in supination, and while he has no pain, if he loafs he is good for about two miles only, then has pain and stiffness. Is also stiff of mornings. Pain all referred to region below external malleolus where the thickening is heavy. He has backed and filled for two months but, having decided he is useless as things lie, he is to come up for operation June 15th²³.

CASE XI—It is only fair to give the other cases—non-operative.

M B, aged twenty-nine. Navy yard electrician, referred by Maj E K Sprague of the Marine Hospital of the Public Health Service of the Treasury Department, had had a double calcis fracture. He fell January 8, 1920, a distance of eighteen feet. Treated without reduction for seven and a half weeks. Then had some sort of correction under ether and a fortnight more of "cast" treatment. Has walked since then.

Examined, F J C, June 11, 1920. Showed clearly enough fracture of os calcis right and left. On the right it was not so bad—motion fair, pain little, bony thickening reasonable. On the left less motion and massive thickening to the outer side but little pain. This case looked hopeful.

Given lift inside heel, right one-quarter inch, left one-sixth inch, and shown how to do rotation exercises. (The patient is far above the average intelligence of the Navy's civil employees and likely to help.) September 16, 1920, he was "almost normal" as to motion and function.

Last seen October 20, 1920, he had practically recovered, without operation.

CASE XII—J P, aged thirty-four. Shoe-hand. March, 1921, fell twelve feet, landing on heels. Examined by F J C, May 9, 1921. (Referred by the Federal Mutual Liability Insurance Company.) A small man, not robust, walks with slight limp. The limp, analyzed, is a failure of the clean "take-off" on the right foot. No flattening of "arch." A good deal of thickening below the external malleolus with limitation of pronation and supination reduced to about one-third normal.

Physiotherapy treatment recommended and now being carried out.

He is gaining satisfactorily and will probably be restored to an approximate normal grade *without operation*. Motion June 21, 1921, almost normal.

CASE XIII—D V. A case of *avulsion* fracture—operated with entire recovery—does not really belong in this series.

CASE XIV—Lahey. Fresh fracture, reduced by mallet remodelling. Now, after six months, back on his job as apartment-house janitor not quite as good as new but serviceable.

CASE XV—H, machinist. Fresh fracture of os calcis from fall. Sent to my service at Public Health Hospital No 36, and reduced by the usual remodelling with the hammer and freeing of the joint motion with the hand. Seen June 7, 1921, three months later. Is back on the job, practically normal in stance and in motion.

OLD OS CALCIS FRACTURES

CASE XVI is one on my service at the City Hospital on which I have no record data at the moment. This was a boy of twelve with a cracked os calcis on one side, a fractured os calcis with displacement on the other, a fracture not only with displacement, but with flattening and thickening as usual. Grace to his years, he has done well, and now, about eight months later, the case has become one of flaccid flat-foot on both sides, now being handled by plates and exercises with notable good results, so long as he wears the "rocker" plates. There is *no* disability, with the pronation corrected.

Let us not forget that these heel-lesions carry a very large chance of flat-foot in convalescence even if there is no bony valgus deformity. Flat-foot symptoms in os calcis cases can be treated orthopædically with physiotherapy after care.

Cases with marked thickening to the outside, with pain on walking or standing, nearly always call for operative interference, soon or late, they can, however, be so handled as to do away with most of the deformity, with most of the loss of motion and with most of the symptoms.

That this is possible is not sufficiently understood.

It is true that no one of the many crippled from injuries of this sort should be let drift along for many months without a trial of more modern methods.

All of them, I think, can be improved by operation and most of them set in the way of an improvement that presently brings them back into the wage-earning class.

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² Os Calcis Fracture. F J Cotton. ANNALS OF SURGERY, Oct., 1916.

³ Never published.

⁴ Dislocations and Joint Fractures. Cotton, W B. Saunders Co. 1st ed. 1910, pp 609-621.

⁵ Boston Med Surg Journal, 1906, clv, p 645.

⁶ Partly, at least, owing to a campaign of reform by the Accident Board. These are primarily painters' and roofers' accidents. The reform accomplished (through the bait of preferential insurance rates) has brought about inspection of ropes and pulleys, and a decrease in os calcis lesions.

⁷ For instance, I have found it practicable to remove nearly all of a comminuted scaphoid bone then to set the foot in proper shape and to secure a total replacement of missing bone.

⁸ I hold no brief against this tenotomy, and do occasionally do it. *Only*, I recognize the disadvantages, and do it only when I must!

⁹ In the evaluation of these results, please allow me a bit of lee-way for personal judgment. I know that two of these men are not yet back at work, but jobs are scarce at present in Massachusetts, and our industrial compensation is pretty liberal.

¹⁰ Anterior arch troubles seem curiously frequent in these cases. They yield to usual handling. There is also, at times, a pain in the outer toes that is probably due not to statics, but to interference with the nerve—also rather common, but fortunately temporary.

¹¹ This was one of those common but yet distressing cases in which a year's idleness means forty pounds gain in weight, otherwise the interval might have been shorter.

¹² This complaint is common, I find, in non-operative as well as operated cases, due, no doubt, to nerve pressure. In no case has it been of serious severity.

¹³ Operated on June 21st. Postero-astragal-calcaneal joint practically destroyed, restoration of lateral motion not very successful at operation, but return of function, including this motion, very satisfactory up to last visit, August 10th.

THE INFLUENCE OF PHYSICAL THERAPY IN REDUCING DISABILITY TIME IN FRACTURES OF THE LONG BONES*

BY JONATHAN M. WAINWRIGHT, M.D.
OF SCRANTON, PA.

IN connection with the papers on fractures presented in the preceding pages, it has seemed justifiable to draw attention to the one definite point indicated in the title of this brief note. Experiences during and after the war have in a general way impressed us with the value of physical therapy. However, the enormous number of cases treated by these methods in army hospitals have no similar series for comparison. For this reason it has seemed profitable to prepare a table showing the disability times in a fairly definite series of injuries, before and after the introduction of an adequate Physical Therapy Department.

The appended table of "before" and "after" cases comprises about 125 in each group. Cases included are uncomplicated simple fractures only; that is, cases of fracture of the humerus with, for instance, musculospiral paralysis, are not included, as they introduce an entirely new element. The figures are desired to show the average disability time of the ordinary case in each group of fractures. Further, the table only includes mine or railroad employees over fourteen years of age.

A study of this table gives very convincing mathematical evidence of the great economic value of physical therapy. In fractures of the clavicle and radius or ulna, where the disability times should not be long under any system, it has, of course, been impossible to cut the time to a large degree. But even here the disability in each case has been reduced over 10 per cent. For the femur, tibia or fibula the reduction has naturally been larger, *i.e.*, over 25 per cent. The reduction for the lower leg has been practically one month, and for the femur, two months. Speaking in terms of cash only, this reduction has saved the corporation I represent about \$4000 a year. And this limited fracture group is a small part of the total injuries of a year.

The most important deduction to be made from this study is the great advantage, almost the necessity for the establishment of a physical therapy department in every large general hospital.

* Read before the American Surgical Association, June 14, 1921.

PHYSICAL THERAPY IN FRACTURES

TABLE SHOWING REDUCTION OF DISABILITY TIMES IN FRACTURES OF THE LONG BONES AFTER
ESTABLISHMENT OF PHYSICAL THERAPY GYMNASIUM AT MOSES TAYLOR
HOSPITAL, SCRANTON, PA

	BEFORE	AFTER	Saving in days	Percentage improve- ment in dis- ability time
	Days disabled	Days disabled		
Clavicle	67	59	8	12
Humerus	125	90	35	28
Radius, ulna, or both	76	64	12	16
Femur	239	180	59	25
Tibia, fibula, or both	121	92	29	24

Times are for uncomplicated simple fractures Males over fourteen only All
mine or railroad employes

OPERATION FOR THE CURE OF ANEURISM*

BY ARCHIBALD MACLAREN, M D

OF ST PAUL, MINN

IN preparing for an operation on a case of traumatic popliteal aneurism recently, I reviewed the literature on this rare condition, and found that the procedures advocated by Watson Cheyne, in 1900, and also by Bull, in 1904, had all been abandoned for the new operation advised by Doctor Matas. The cause of this change was due to the fact that in the older procedures so many cases of gangrene occurred or the cases which escaped gangrene were followed by a relapse of the aneurism.

Several modern text-books give the impression that reconstructive aneurismorrhaphy (Matas) was the operation usually employed. Illustrations showing the sacciform aneurism, depicting the false aneurismal sac, and also the picture of the fusiform sac, with the gutter in the bottom to mark the original vesicle wall, were both featured in every text-book.

In Matas' second presentation of this subject before the American Surgical Association in 1905, he complains "that great confusion and misapprehension still exists in the minds of many surgeons who had obtained their information from abstracts and second-hand descriptions given in the journals and text-books." In his report Matas listed twenty-four cases, five of his own and nineteen by other operators. Of the total number, eighteen were oblitative cases and four sacciform aneurisms where the lumen of the parent artery was restored by the closure of the single orifice of communication. Three cases of fusiform aneurism were operated upon for restoration of the artery wall by arterioplasty—only one remained cured when last heard from at the end of eighteen months, of the other two, one relapsed, and one was operated upon again for obliteration of the sac, two weeks after the arterioplasty.

Fortunately, for me and my patient, I came across a very sane and practical article on this subject by Dr John Gibbon, of Philadelphia. Gibbon's conclusion, after a large experience with these operations, was, that arterioplasty or reconstruction of the vesicle wall was seldom safe or necessary—that in practically all cases the oblitative aneurismorrhaphy of Matas was the operation of choice.

CASE HISTORY—E H, age twenty-two years. Referred to me by Doctor Hopkins, of Arlington, South Dakota. When six years of age, he had a large abscess in his left kidney region which was opened and drained. At the end of four weeks the drainage ceased and the opening was closed, and he had no further trouble with his kidney. When the boy was fourteen years old, which would be about eight years ago, he was accidentally shot with a 22-calibre rifle. The muzzle of the

* Read by title before the American Surgical Association, June 14, 1921



FIG 1 --Showing swollen condition of affected leg

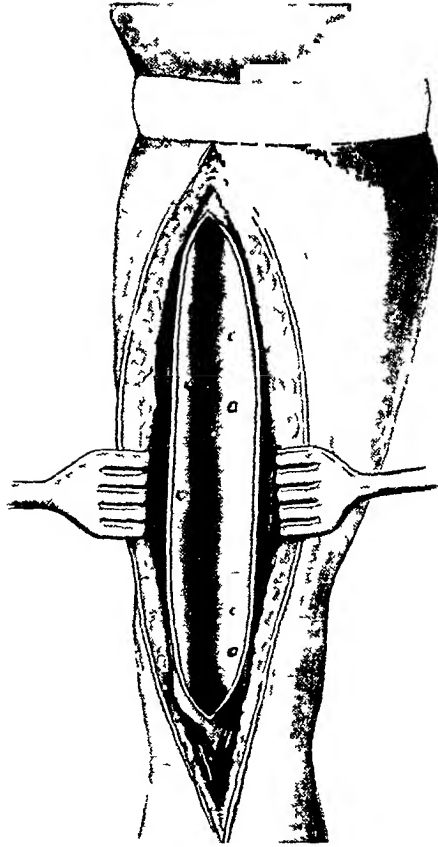


FIG 2 --Fusiform traumatic aneurism of the femoral artery

THE CURE OF ANEURISM

rifle was about four feet away from the point of entrance. The ball struck him from behind in the upper part of the right popliteal space, probably injuring the arterial wall and imbedding itself in the internal condyle of the right femur. There was not much bleeding. His physician put him to bed for one week. He has not had any trouble with his leg until quite recently. He has noticed that the right leg was larger than the left, and that it tired more quickly. It might be interesting to note, that this boy entered the United States Army and served through the entire war, including service in France.

In the fall of 1920, he commenced to have a sharp pain in the right groin, especially when tired. He consulted Doctor Hopkins, who made an examination for hernia. No hernia was found, but there was a marked dilatation of all the superficial veins, especially in the foot and calf of the leg. There was a very marked thrill all through the leg, over every artery and vein. This thrill extended up into the iliac vessels. The upper leg was one and one-half or two inches longer than the left. The most marked swelling and the maximum thrill were over the popliteal space.

Examination of abdomen and chest showed nothing pathological, urine and Wassermann were negative. The X-ray roentgenogram showed the bullet imbedded in the internal condyle of the right femur, but no necrosis or other diseased condition about the bullet.

The diagnosis of a large fusiform traumatic aneurism was made and operation was advised.

The operation was performed at the Miller Hospital, St. Paul, December 16, 1920. An Esmarch was applied about the upper thigh, just below the fold of the buttock. An incision over the dilated artery demonstrated a fusiform swelling of the femoral artery, extending up to the Esmarch and down to the lower end of the popliteal space. Upon opening the sac and cleaning out the clots we found many large vessel openings inside of the sac—about twenty in number. It was not possible to determine which one of these openings communicated with the vein, no gutter or other evidence of the original arterial wall was present, there was no false sac. The entire thickness of the arterial wall constituted the aneurismal sac. Each one of the openings into the sac was separately sutured with fine chromic catgut.

The constrictor was loosened. One or two bleeding-points were reinforced with chromic catgut. Then the entire sac was obliterated by several continuous chromic catgut sutures. The collateral circulation was so good in this diseased leg that when the operation was finished the color and superficial heat were just as good, if anything even better, than in the normal leg. The thrill entirely disappeared and has never returned. He made a rapid recovery, was able to walk in three weeks and is now well except for a slight keloid condition of the scar. Doctor Hopkins reported on March 16, 1921. "The leg is swollen below the knee, but above that point is normal. On June 2nd, Doctor Hopkins writes "Regarding the present condition of our patient, I would say, that he is in good shape, the wound is entirely healed, and there is no evidence of a relapse of the aneurism.

LIGATION (PARTIAL OCCLUSION) OF THE ABDOMINAL AORTA FOR ANEURISM*

REPORT OF A RECENT CASE WITH A RÉSUMÉ OF PREVIOUS CASES

BY GEORGE TULLY VAUGHAN, M D
OF WASHINGTON, D C

Just one hundred and four years ago, Astley Cooper did the first operation of ligation of the aorta and the operation has been performed about nineteen times since, but in no case can it be said to have been successful in man according to the cases reported up to the present time. Death has always followed in from a few hours to a few months from shock, hemorrhage, infection or something directly connected with the operation, except Hamann's case which died from hemorrhage from a bedsore.

Experiments on the lower animals, dogs, sheep, and goats, by Luigi Porta in 1838-40, both by partial and complete occlusion of the aorta by ligature, proved that such operations were by no means necessarily fatal, and he published some beautiful drawings of the collateral circulation established in animals whose aortas had been ligated more than a year before.

In more recent years the work of Halsted along the line of partial and gradual occlusion of large arteries by means of metallic bands has been of great value in demonstrating a method of occlusion without causing ulceration of the walls of the vessel.

In five of the twenty cases mentioned in this article, including my own, there was no ulceration, and in none of the five was there complete occlusion of the lumen of the aorta, and these were the only patients, excepting Keen's, who lived long enough to give any expectation of complete recovery from the operation. Tillaux's patient lived thirty-nine days, Halsted's two patients forty-one and forty-seven days respectively, Hamann's six months and two days, and my patient is still living and working, one year and four months after operation.

H B, male, white, age thirty-nine, bricklayer, was referred to me by Dr James A Gannon.

History—Had typhoid fever at ten years of age, "blood poisoning" at nineteen, and soon after that a chancre. For three years he has been suffering with pain in the abdomen and back. Two years ago his appendix was removed, and as he continued to have pain and developed a swelling in the abdomen just above the navel he was again operated on, November 5, 1919, when the aneurism was discovered and the operation was carried no further. As the patient gave a positive reaction to the Wassermann test, he was treated for a while for syphilis. This had no appreciable effect on the aneurism, therefore I decided

* Read before the American Surgical Association, June 16, 1921

LIGATION OF ABDOMINAL AORTA

to try ligation of the aorta according to Halsted's principle of incomplete occlusion of the lumen of the vessel, using a piece of tape instead of the metal bands January 23, 1920, the abdomen was opened, the aneurism, about one inch and a half in diameter, seemed of the saccular type and sprang from the left side of the aorta behind the pancreas about opposite the origin of the superior mesenteric artery It was decided to place the ligature below the aneurism according to the Brasdor method The peritoneum was opened, the aorta exposed and a piece of cotton tape one-half inch wide was carried around the vessel about two inches above its bifurcation and just below the origin of the inferior mesenteric artery Two turns of one end of the tape made the surgeon's or friction knot, which was drawn gradually tighter and tighter until pulsation was no longer perceptible in the iliacs and barely so in the aorta below the ligature, then the knot was completed, the ends of the tape cut off and the abdomen closed

Nothing unusual was noticed afterwards, such as increased blood pressure and pains in the lower extremities when the patient recovered from the anæsthetic

Next day his condition was satisfactory—no pain or paralysis of legs, and the color and temperature were good Pulse distinctly felt in left foot but none in the right—both equally warm and comfortable A slight blowing sound could be heard by the stethoscope over the left external iliac, but none over the right Pulsation was faintly perceptible in the left iliac but absent in the right

Recovery from the operation was normal but patient was kept in bed most of the time for two months and potassium iodide was given When he left the hospital March 30th the pain in back and abdomen was much less, the murmur of the aneurism was not as loud but was softer and more musical in character

Some time during the month of May, against advice, patient returned to his work as bricklayer

June 18, 1920, he was examined Says he feels better than he has for years—no pain of consequence and he eats, sleeps and works well The aneurism seems about one-half its original size A soft whining sound is heard directly over the aneurism and a rough sound over the aorta just below—both systolic No sound over external iliacs A feeble pulse is felt in the left iliac and none in the right

August 29, 1920 Examined patient Thinks he is entirely well, no pain, has gained twenty pounds in weight, and does eight to ten hours work bricklaying daily The tumor cannot be made out by its pulsation The circulation in the lower extremities is the same as before described

February 13, 1921, when the last examination was made, one year and twenty-one days after the operation, everything seemed satisfactory except the patient's habit of going on occasional alcoholic sprees He was hard at work and looking well No aneurismal pulsation could be felt but a soft whining note ending in a rough note below could still be heard in the region of the aneurism and the aorta just below A faint pulsation could be felt in the left iliac and dorsalis pedis, none

in the right iliac or vessels below, yet the two feet were normal in color, temperature and sensation

When last heard from in May, 1921, one year and four months after operation, patient was in good condition, but just recovering from a spree

Below is given a résumé of nineteen previous cases of ligation of the aorta and five cases of suturing or plugging of aneurisms of that vessel

LIGATION

1 June 25, 1817, Astley Cooper ligated the abdominal aorta for a left iliofemoral aneurism in a man thirty-eight years of age Death in three days

2 July 5, 1829, James ligated the abdominal aorta for aneurism of the left external iliac artery in a man forty-four years old Death from shock three and one-half hours later

3 January 26, 1834, Murray ligated the abdominal aorta for right iliofemoral aneurism in a man thirty-three years old Death in twenty-three hours

4 August 5, 1842, Monteiro ligated the abdominal aorta for right iliofemoral aneurism in a man thirty years old Death from hemorrhage ten days later

5 June 21, 1856, South ligated the abdominal aorta for aneurism of the right common and external iliac arteries in a man twenty-eight years old Death forty-three hours later

6 March 8, 1868, Wm Stokes ligated the abdominal aorta just above the bifurcation for right iliofemoral aneurism in a man fifty years old—silver wire ligature Death from shock twelve and three-quarters hours later

7 March 30, 1868, Hunter McGuire ligated the abdominal aorta for aneurism of the left external, and both common iliacs and the aorta, in a man thirty years old—the left ureter was included in the ligature Death in a few hours

8 August 6, 1869, P H Watson ligated the abdominal aorta for iliac aneurism in a patient, sex and age not given Death from gangrene sixty-five hours later

9 August 19, 1870, Czerny ligated the abdominal aorta (*thinking it was the iliac*) for gunshot wound of the thigh in a soldier twenty-seven years old Death in twenty-six hours

10 January 19, 1879, Czerny ligated the abdominal aorta between the two renals for tumor of the left kidney in a man fifty years old Death in ten hours

11 July 3, 1890, H Milton ligated the abdominal aorta just below the renals for a ruptured aortic aneurism in a man forty-five years old Death from anæmia and shock twenty-four hours later

12 December 12, 1899, W W Keen ligated the abdominal aorta just below the diaphragm, for ruptured aortic aneurism in a man fifty-two years old Patient lived forty-eight days There *was no suppression of urine* and the bruit in the aneurism did not disappear Death from hemorrhage from the ligature cutting through

13 January 20, 1900, Tillaux ligated the abdominal aorta just

LIGATION OF ABDOMINAL AORTA

above the bifurcation for ruptured left iliac aneurism in a man fifty-six years old. Death thirty-nine hours later. He grew gradually thinner until death. There was no ulceration at the point of ligation and the lumen of the aorta was not completely obliterated, permitting the passage of a grooved dissector.

14 May 1, 1901, R. T. Morris occluded the abdominal aorta just above the bifurcation with a soft rubber catheter and clamp forceps for aneurism proximal to the ligature in a woman twenty-four years old. Death fifty-three hours later from infection caused by gangrene of bowel in contact with the forceps.

15 June 20, 1904, A. Guinard ligated the thoracic aorta about the level of the ninth dorsal vertebra for aneurism of the end of the arch. Death three days later from suppression of urine. Guinard remarks that ligation above the renal arteries is incompatible with life, evidently not knowing the history of Keen's case.

16 January 1, 1905, W. D. Scott ligated the abdominal aorta just above the bifurcation for gunshot wound of the aorta and intestines, using a soft rubber catheter and forceps, in a negro woman twenty years old. Death one hour later.

17 December 18, 1905, W. S. Halsted applied his aluminum band to the thoracic aorta about 7 cm. above the diaphragm, partially occluding the lumen, for aneurism of the upper abdominal aorta. Pain was much relieved. January 10, 1906, twenty-three days later, a second band was applied to the abdominal aorta just below the inferior mesenteric artery distal to the aneurism, just occluding the femoral pulse. Death eighteen days after the second operation from rupture of the aneurism. No ulceration at sites of bands.

18 February 23, 1909, Halsted applied his band to the aorta between the renal and superior mesenteric branches for aneurism extending from the renal arteries to the bifurcation of the aorta in a physician fifty-three years old, producing partial occlusion. Great relief from pain. March 5th there was enlargement of the aneurism and signs of infection, and Finney wired the aneurism. March 12th. Death April 11, 1909, from infection from a psoas abscess.

19 September 11, 1917, Hamann ligated the abdominal aorta just above the bifurcation for a pulsating tumor in the pelvis for which the right internal iliac had been ineffectually ligated, in a man fifty-one years old. Death March 13, 1918, six months and two days later, from hemorrhage from a bedsore. At necropsy no aneurism was found and the aorta at the site of the ligature was found only partly occluded having a lumen less than $\frac{3}{16}$ inch in diameter.

SUTURING AND PLUGGING OF THE SAC

1 April, 1906, R. Lozano reports an operation on the abdominal aorta by Matas' endo-aneurismorrhaphy for aneurism. Death eight hours later from shock and hemorrhage—the diseased artery walls would not hold sutures well.

2 In the summer of 1906, John C. Munro ligated the right phrenic artery and the coeliac axis and sutured with catgut the stump of the

sac of an aneurism of the aorta above and behind the coeliac axis, in a man thirty-nine years old Death that night from hemorrhage

3 July 30, 1904, Tuffier exposed by dissection an aneurism of the arch of the aorta threatening to rupture through the skin No pedicle to the sac was found and adhesions were extensive, so extirpation was abandoned and the thorax closed Death five days later, suddenly—the operation not having hastened his death

4 October 29, 1909, Tuffier operated on a man forty-nine years old, the aneurism showing as a pulsating tumor in the right upper sterno-costal region over which the skin was thin and adherent In exposing the aneurism by turning back flaps, it was ruptured, and, to stop the bleeding, the tip of the gloved left index finger was thrust into the opening A tampon was then made by stuffing the finger of a glove, the finger was withdrawn and the stuffed glove finger substituted and sewed into place and the wound closed with drainage The patient was up on the eleventh day and walking on the thirteenth Next day, the fourteenth, the tampon was replaced by a new one of the same kind Two days later death occurred suddenly, but not from hemorrhage or asphyxia

5 Kummel reports, in the *Deutsch med Wochenschrift*, April 2, 1914, the case of a man forty-five years old, with an aneurism of the thoracic aorta just above the diaphragm The aneurism was exposed by resecting three ribs close to the spine and just above the diaphragm, the aorta was controlled above and below with fingers, the aneurism slit open, the clots turned out, and the walls of the sac united with two rows of continuous sutures down to the lumen of the artery Death in a short time from shock

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A NOTE ON THE TREATMENT OF SECONDARY HEMORRHAGE FROM THE BRANCHES OF THE COMMON CAROTID ARTERY*

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It was a teaching of Kocher that to tie the common carotid artery in a person past middle life was always dangerous and, in the arteriosclerotic, equivalent to a death warrant.

It would seem that some surgeons tie this vessel rather indiscriminately and for somewhat trivial reasons, claiming to see no ill results. Their luck is better than mine.

I have ligated the common carotid in but three subjects who were over forty years of age. One was for a carotid body tumor that completely surrounded the bifurcation and had materially reduced the calibre of the internal division. This patient survived without immediate symptoms of brain ischæmia, but the later history is not known. In the other two cases, although partial compression of the artery preceded the ligation for a period of more than twenty-four hours, both died with marked cerebral symptoms apparently referable to ischæmia. An autopsy could not be obtained in either case.

I have ligated the common vessel about six times in people under thirty years with only transient cerebral symptoms in one case, but I am so convinced of the dangers of this ligation in elderly people that I allowed one old man to bleed to death while making puttering attempts to control a secondary hemorrhage from one of the larger branches of the external carotid rather than tie the common artery, which I knew perfectly well to be the only sure method of controlling the bleeding.

It is an old teaching in English surgery, rather generally accepted, that when a true secondary hemorrhage occurs in the neck from one of the primary divisions of the common carotid or from one of the primary branches of the external carotid near the bifurcation, only ligation of the common artery will prevent fatal hemorrhage. Death may occur within a few minutes or the first bleeding may be slight and cease spontaneously or in response to some minor proceeding, but it will recur and continue to recur. The reasons for this are that the vessel walls are held patent by the induration of the tissue and that the width of the vessel is so great compared to its length that the clot has no opportunity to organize. The secondary hemorrhage here referred to is that due to infection, the ligature cutting through the vessel wall, or the clot being dissolved or blown out before permanent repair is established.

In my own practice I have not seen a true secondary hemorrhage in the

* Read before the American Surgical Association, June, 1921.

neck, corresponding to the above definition, in over eight years, or since first heeding the advice of Billroth to neither suture any wound in the floor of the mouth nor to suture without free drainage any wound that contained a ligated carotid or a ligated primary branch

I have had, however, two cases that somewhat approximated true secondary hemorrhage, the successful outcome of which suggested a plan that I hope might prove efficient in dealing with true secondary hemorrhage in this locality.

The first of the two cases just referred to was a hemorrhage following the throwing off of a slough after a complete removal of the tongue, with a cautery, right at its attachment to the hyoid bone. In this case the bleeding ceased spontaneously, showing that the fluids in a foul pharynx would not necessarily prevent the formation of a permanent clot in the open stump of the lingual artery.

It has been my custom for some time in dealing with carcinoma of the tongue or pharynx to ligate the lingual and facial vessels as far from their origin as possible, usually about an inch, and leave the ligated ends protruding into the pharynx with no protection whatsoever.

The second of the two cases referred to above is the only one of the cases treated by the method just described in which secondary bleeding occurred and this was not a true secondary hemorrhage as above defined. Three days after removal of the tongue and following a coughing spell, there was a persistent arterial bleeding, the blood coming from within the right side of the pharynx. On opening the right half of the submaxillary wound it was found that the stump of the facial artery stood up in the pharynx very much as it was at the time the submaxillary wound was closed at operation, and that just proximal to the ligation there was a fair-sized uncontrolled branch the continued circulation in which prevented the formation of a firm clot in the stump of the artery. Further, it was found that another very minute branch that arose close to the preceding had been partially torn from the indurated wall of the stump and there was a pulsating stream of blood the size of a pin. No attempt was made to ligate the bleeding point, but a ligature was placed on the uncontrolled branch referred to above and, after a few minutes' pressure on the stump, all bleeding ceased. The wound was left open for observation and next day the stump of the facial artery which had been nearly an inch long had shrunk entirely out of sight behind the digastric muscle, and it gave no further trouble.

My conclusions from personal observations are

1 That secondary hemorrhage of the carotid artery and its branches is to be prevented by not suturing wounds that extend through the floor of the mouth and by packing or freely draining all wounds in the neck, above the level of the thyroid cartilage, that contain a ligated primary branch of the carotid artery.

2 That secondary hemorrhage from a ligated primary branch might possibly be controlled by previously having placed the ligature as far from the

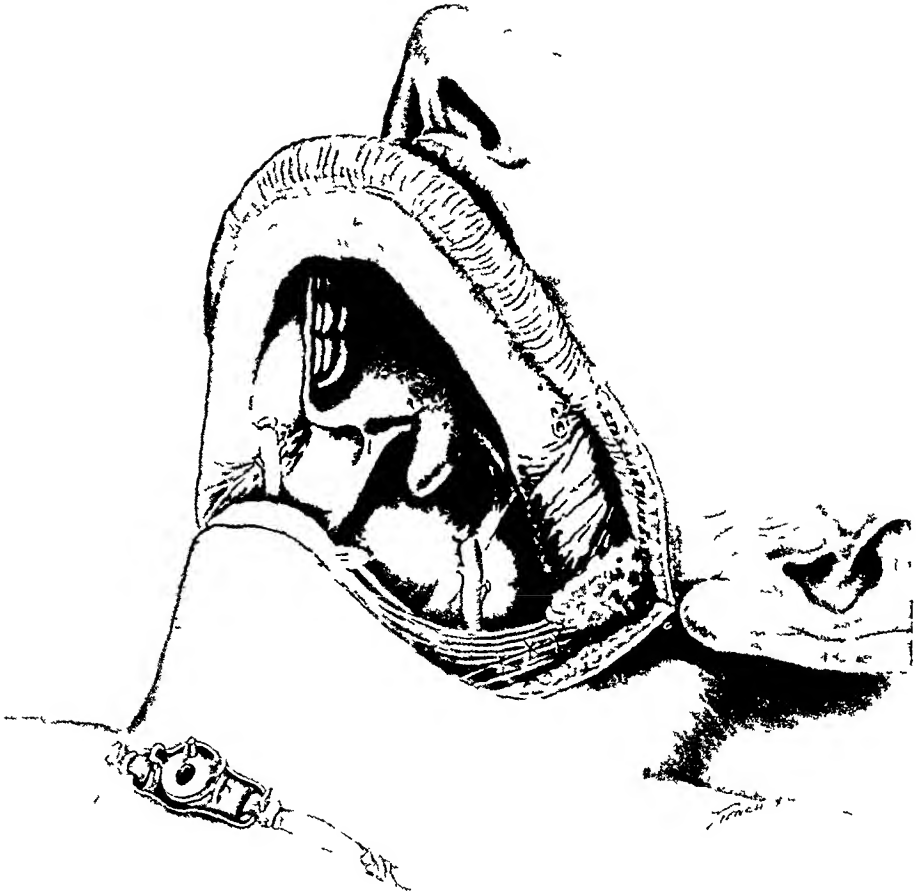


FIG. 1 --Showing the appearance of the space left after the removal of the tongue and submaxillary structures after the author's method of radical operation for carcinoma of the tongue. (Note) Attention is particularly invited to the facial arteries standing up in the pharyngo-buccal cavity. They receive no further attention. The wound is closed by turning down and suturing the submaxillary flap of skin and platysma myoides muscle which is here shown turned up over the chin.

(Note) Operation for Advanced Carcinoma of the Tongue or Floor of the Mouth. Surgery Gynecology and Obstetrics (Feb 1920)

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carotid as possible and when bleeding actually occurs, (*a*) to free the stump from the surrounding indurated tissues, (*b*) to ligate any branches that are given off proximal to this ligature and, if necessary, to loosely re-ligate the stump itself as far from its origin as possible

If it is found necessary to place the ligature on the bleeding stump so close to the external carotid as to preclude the formation of a proximal clot, then the external carotid itself should be exposed and a ligature placed on each branch and on the trunk at least an inch from the bifurcation, in the hope of establishing a permanent clot in the external carotid itself. In this latter fashion I have successfully avoided ligating the external carotid dangerously close to its origin in a wound I knew would become infected

THE CAUSATION AND AVOIDANCE OF CEREBRAL DISTURBANCES IN LIGATION OF THE COMMON CAROTID ARTERY*

BY LEONARD FREEMAN, M D
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THE danger to the brain in ligating the common carotid is generally recognized and has been emphasized in all our text-books. For instance "The surgeon is always in doubt whether the patient will come out of the anæsthesia, and if he does whether he will exhibit hæmiplegia or progressive cerebral softening" (Binnie), and again, "From the beginning of carotid surgery to the present time the dread of cerebral disturbances has invested the technically simple operation of ligating the common carotid artery with a gravity and anxiety, that are associated with few other ligations" (Matas).

The percentage of cases in which the brain is affected has been placed as high as 54.5 (Le Fort), but 20 to 25 per cent is generally recognized.

The almost universally accepted cause is anæmia with softening of the brain, from inadequate collateral circulation, due to defects in the circle of Willis. This plausible theory is supported by—(1) the occasional finding of such circulatory anomalies in fatal cases, (2) the possibility of producing cerebral softening" (Binnie), and again, "From the beginning of carotid common occurrence of these disasters after middle life, which can be explained by lessened dilatibility of the collateral vessels from increased rigidity.

The acceptance of the anæmia theory naturally has led to various procedures to determine the presence or absence of an adequate collateral circulation before resorting to permanent closure of the carotid, such as—temporary ligation (Halstead, Jordan), gradual narrowing of the arterial lumen by encircling metal bands (Halstead, Matas), which is supposed to give time for the collaterals to expand, simultaneous ligation of the internal jugular (Ceci), with the idea of inhibiting cerebral anæmia, and lastly, the abandonment of ligation in favor of aneurismorrhaphy, or arterial suture in the case of wounds, so as to preserve the circulation (Rehn).

Scant attention has been given to the objections to this time-honored theory. It fails to explain

- 1 The interval which nearly always occurs between the operation and the advent of cerebral symptoms, which varies from a few hours to several days, or even two or three weeks. If anæmia were the cause, symptoms should occur at once.

- 2 The *suddenness* of the onset of the symptoms. If produced by anæmia, they should come gradually.

- 3 The greater frequency of brain complications in ligation of the common over that of the internal carotid. Theoretically, it should be the reverse,

* Read before the American Surgical Association, June 14, 1921.

owing to the possibility of a retrograde flow of blood from the external carotid. This, in fact, has actually been observed to occur in certain operations in the neck

4 Autopsies in which no arterial sclerosis and no deficiencies in the circle of Willis have been found (Zimmermann)

5 Cases in which the artery was temporarily compressed for a long time before operating, without ill effect, with disaster resulting after ligation (Goldhammer)

6 Cases in which a preliminary, gradually increasing constriction of the lumen by metal bands was resorted to, and still cerebral softening followed permanent tying of the vessel (Gruber and Werner)

7 A case (Perthes) where the common carotid was temporarily tied during the extirpation of a cervical tumor, but as soon as the ligature was divided and the *circulation* reëstablished hæmiplegia followed, which cannot be explained by anæmia

Another explanation for softening of the brain following ligation of the common carotid was advanced by Zimmermann, in 1892, and supported more recently by Stierlin, Perthes¹ and a few other observers. Although receiving scant recognition it has much in its favor and deserves serious consideration. It is based upon the fact that when the carotid is tied its inner coat is ruptured, which leads to the formation of a thrombus, and it is either the direct extension of this thrombus, or much more frequently the lodgment of detached emboli, which may block the cerebral arteries and causes anæmia and softening. Rarely, when the intima is smoothly divided, thrombosis does not result, but where the edges are ragged or curl into the lumen of the vessel coagulation is inevitable.

The points in favor of this theory are numerous and convincing. It explains, for instance, why—

1 There nearly always is an interval between the operation and the cerebral disturbances, during which a clot is formed and emboli detached

2 The brain symptoms come suddenly, like an apoplectic stroke, due to the lodgment of emboli

3 Autopsies done in fatal cases following ligation, and also experiments upon animals, repeatedly have demonstrated the presence of ascending thrombosis and of embolism

4 Tentative compression or temporary ligation, even when unaccompanied by symptoms, does not insure that disaster will not result when the artery is permanently tied, and neither does the gradual diminution of the arterial calibre by metal bands or otherwise

5 Disaster is more frequent in ligating the common than the internal carotid, because the return flow from the external carotid is particularly liable to detach emboli from an extending thrombus in the main arterial trunk

6 The release of a temporary ligature, with *reestablishment* of the circulation, may initiate cerebral trouble, as demonstrated by Perthes

The preponderance of softening of the brain in the aged is not difficult

to understand because of the tendency to increased brittleness of the internal coat due to arteriosclerosis. This leads to increased likelihood of rupture from ligation and to roughness of the torn edges, thus increasing the tendency to thrombosis.

That ligation does not always produce trouble is clear when one remembers that the furrow produced in the inner coat by the ligature is sometimes so smooth that coagulation fails to occur, and that emboli do not always become detached even if a thrombus is present.

The fact that cerebral symptoms once in a while occur during an operation, so that the patient comes out of the anæsthetic paralyzed, does not militate against the embolus theory. Such occurrences usually take place in connection with aneurisms, and admit of explanation on the ground that emboli have been dislodged by manipulation of the aneurismal sac. This has led Perthes to emphasize the necessity of closing the distal artery before the sac is touched.

Unquestionably it cannot be denied that anomalies in the circle of Willis occur, but it is significant that when they have been found after death following ligation of the carotid, it has not been proved that thrombosis or embolism was not present also. Nevertheless, in spite of theoretical considerations, we are not yet warranted in assuming that brain disturbances do not occur occasionally from anæmia alone. Such an instance recently has been reported by Moser,³ in which the marked symptoms resulting from a temporary ligation of the common carotid immediately were relieved by removal of the ligature. In such a case, however, a question must always arise as to the permanency and seriousness of the cerebral condition.

If this embolic theory is true, the older method of ligation should be discarded in favor of one which does not cause rupture of the internal coat, thus avoiding the formation of a thrombus. One way of accomplishing this is by the use of a metal band (Halstead, Matas), and another by the employment of a strip of fascia lata. The latter is preferable because it is not a foreign body, is less likely to injure the artery, and is always at hand when wanted.

The technic described by Perthes is simple (see illustration). A strip of fascia lata, three or four inches long and half an inch wide, is obtained from the thigh, wrapped once or twice around the artery, tied in a half-knot, and the knot secured by a few sutures. It is pulled just tight enough to obliterate the vascular lumen without rupturing the internal coat. If desired, additional pressure and security against injury may be had by folding lengthwise another fascial strip several times upon itself and placing it between the knot and the artery. As is well known, fascia lata will not stretch or break easily, hence it makes an ideal material for the purpose.

It goes without saying that aneurismorrhaphy, as well as the suture of wounded vessels, cannot be discarded, but they should be employed only when they can be done easily and safely.

Fig 3



Fig. 4

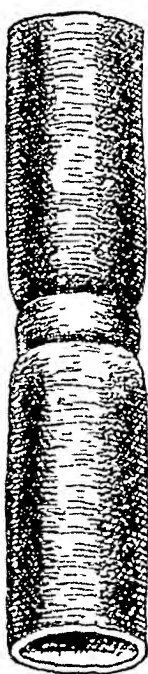


Fig 5

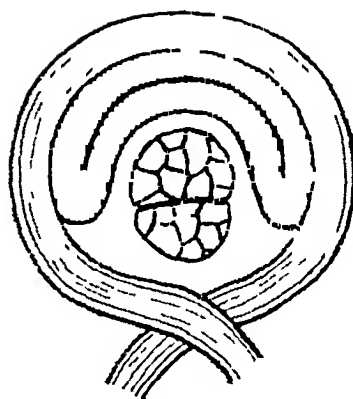


FIG 1—Ligation of common carotid artery with a strip of fascia lata, according to Perthes
(From Archiv Klin Chir)

LIGATION OF THE COMMON CAROTID ARTERY

The following case is reported in order to add to the statistical material which will assist in deciding which of the two theories is the correct one.

A woman, about fifty years of age, with a blood-pressure of two hundred, noticed, four or five months previously, a beginning swelling just above the right sterno-clavicular junction. This was accompanied by a disagreeable throbbing in the neck, and neuralgic pains over the right side of the head posteriorly, and the entire right shoulder. There was also difficulty in swallowing and a sense of choking. An X-ray picture demonstrated, however, that the dysphagia was due to a cardiospasm (pressure on the pneumogastric?) and not to direct interference with the œsophagus. These disturbances increased rapidly and finally became so annoying that she applied to her physician, Dr. Alice Guthrie, for relief. Examination revealed a pulsating, expansile tumor, about as large as a walnut, which was evidently an aneurism of the first portion of the carotid, or of the innominate.

An operation was done, on January 3, 1921, in which was found a marked fusiform dilatation of the innominate, the first part of the subclavian and the first part of the carotid. Although the condition did not seem bad enough to justify a ligation of the innominate or subclavian, it nevertheless demanded that something be done to relieve the symptoms and prevent an increase of the trouble. Hence the following procedure was decided upon. Two strips of fascia lata were obtained from the thigh, each about four inches long and one-half inch wide. One of these was wound twice around the dilated innominate and secured to itself by stitches. It was drawn tight enough to lessen the calibre of the vessel without obliterating it, the amount of tension being regulated by the distal pulsation of the artery. By this means it was hoped to reinforce the vessel and prevent its further enlargement, according to the suggestion of Halstead.

The other strip was given a double turn about the lower end of the carotid and tied in a half-knot, which was secured from slipping by sutures of chromic gut. This permanent ligature was carefully drawn just tight enough to stop the distal pulsation without danger of rupturing the internal coat.

Convalescence from the operation was without incident, there being no cerebral disturbance of any kind. The pulse in the right wrist remained normal, while that in the right common carotid was absent and remained so for at least two weeks.

The patient was relieved of all her annoying symptoms, including the throbbing, the cardiospasm and the various neuralgias. At the end of a month she was still in excellent condition and extremely grateful for the relief obtained. The pulsating and expansile tumor was no longer to be felt at the root of the neck, but a comparatively feeble pulse had returned in the carotid, due either to a collateral circulation from the back-flow through the external carotid or to reestablishment of the circulation through the point of ligation. If deemed necessary, the former occurrence could be prevented by simultaneous ligation of the external carotid, and the latter by applying an ordinary ligature to

the common carotid proximal to the fascial band and dividing the artery between them (Perthes)

Summary—1 The great danger from cerebral disturbances in ligating the common carotid artery is universally recognized

2 The accepted theory in accounting for this danger is that of anæmia, due to failure of collateral circulation arising from defects in the circle of Willis

3 An apparently more rational theory, recently emphasized by Perthes, is that of thrombosis at the point of ligation, followed by embolism. This accounts for the suddenness of onset of the symptoms and the greater or less interval which precedes them. The preponderance of cases after middle life is explained by the greater brittleness of the inner coat of the artery producing ragged edges when divided by the ligature and thus inviting thrombosis

4 If this latter theory can be substantiated by experience it will do away with much of the fear and hesitation of the surgeon when confronted by this comparatively simple operation

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¹ Archiv Klin Chir, B 114, p 406, Sept, 1920—Literature

² In this connection it is of interest to note that in one instance a patient upon whom I had performed a hysterectomy for a uterine fibroid came out of the anæsthetic with a hæmiplegia from which she subsequently died

³ H Moser, Zentralblatt f Chir, No 9, 1921, p, 321

SURGICAL ASPECT OF TUMOR OF THE BRAIN*

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BOTH the morbidity and the mortality caused by all tumors of the brain, all tumors of the meninges and all tumors of the inner aspect of the skull result largely from increased intracranial tension, local, general, or both. The word tumor as here used is intended to apply also to infectious granulomata. These pressure phenomena are the result of an increase in the intracranial content—they are mechanical in origin. In 100 cases studied in the service of Doctors Halsted, Heuer and Dandy¹ they found that in 57 evidence of the increased intracranial pressure was manifested in the X-ray pictures by a separation of sutures. Mechanical defects are best remedied by mechanical measures. These statements, in the present state of knowledge, must, it seems to the writer, be accepted as true. They require qualification and exemplification, but in a general way they present a true picture. Logically, therefore, two facts seem to follow. (1) That all tumors occupying the cranial cavity should be taken into consideration in a discussion of brain tumors, as is done by Hertzler² and other writers. (2) That the subject of brain tumor is a surgical rather than a medical subject.

Last summer in Paris the writer was present at a clinic conducted by a surgeon of decidedly excellent repute. One of the cases was listed as "brain tumor." The operator proceeded to remove a large part of the frontal bone and, very much to his surprise, when the segment of bone came away, the tumor came with it. Technically, it was a tumor of the skull, practically, it was a tumor of the brain. This is not intended as an adverse criticism for the operation was well conceived and splendidly executed, but the incident is related in support of the contention that all tumors occupying the cranial cavity should be considered in discussing the general question as to whether tumors of the brain should be considered as primarily surgical rather than medical. It would seem obvious that if the majority of patients with brain tumor can be relieved or cured by surgery only, then these patients should be considered surgical subjects until the contrary is proven.

As late as 1902 Ransohoff,³ in a paper read before the Surgical Section of the A M A, said "Only 6 per cent of all cases are suitable for operation." Bergmann, as quoted by Hoppe,⁴ came to a like conclusion as the result of a study of 673 cases taken from various sources.

The writer takes it that these authors mean to convey the idea that only about 6 per cent of tumors of the brain *per se* can be removed surgically. Certainly more than 6 per cent of patients with tumors of the brain proper

* Read before the American Surgical Association, June 15, 1921

can be relieved surgically and a still larger per cent can be relieved by surgery if tumors of the meninges and inner table of the skull are included Ransohoff (*loc cit*) puts the three-year recoveries from operation in brain tubercle at over 25 per cent As emphasized by Cushing⁵ it is oftentimes impossible to differentiate between true tumor and what he calls pseudo-tumor cerebri He further quotes and supports the statement of Tooth that even among the fatal cases are "many positive surgical successes, some almost brilliant considering the circumstances, and followed by relief of pain, improvement in sight and mental state and prolongation of life" Cushing operated upon 350 out of a series of 500 Headache is an almost constant symptom of tumor of the brain, and according to Paton, as quoted by Rawling,⁶ either optic neuritis or atrophy occurred in 81.2 per cent of 252 cases Surgery, and surgery only, can relieve either or both of these symptoms in a large percentage of cases Beriel⁷ operated 8 out of 16 cases of glioma and advises calling the surgeon as soon as the diagnosis is made, but insists that no attempt be made to remove the tumor because simple decompression gives better results The position taken by White,⁸ Segun,⁹ V Bergmann¹⁰ and Koplik,¹¹ that gummata, non-localizable tumors, non-encapsulated tumor, tubercular tumor, and tumors of any sort in comatose patients are non-operable is no longer tenable As long ago as 1892 Czerny¹² expressed the opinion that pathologico-anatomical results were not authoritative in brain tumor Wyeth,¹³ prior to 1894, operated two patients in coma due to brain tumor Both patients became conscious and one was able to attend to business for seven months and to execute a will which stood In neither case was the tumor removable It is generally conceded now by surgeons of experience that decompression may be expected to alleviate the distressing symptoms of brain tumor regardless of its location or nature, but it is a humiliating fact proven by an extensive search of the literature that notwithstanding the advice of Cushing,¹⁴ Sachs,¹⁵ Sharpe¹⁶ and others, a large number of patients are allowed to suffer an unconscionable time, amounting in the aggregate to decades, for the want of timely intelligent surgical interference Early operation not only relieves the symptoms but tends to prevent the secondary changes which occur in the brain as a result of the tumor—the hyperplasia of Spiller¹⁷ To allow a patient to go blind or even to allow him to suffer over a long period in the hope of making a complete diagnosis, or in the hope of relief through antisyphilitic treatment, is almost a crime The time which is considered reasonable during which antisyphilitic treatment may be tried is rapidly growing shorter In 1893, C H Mayo¹⁸ said, "tumors diagnosed as gumma should be treated medically for three months" Horsely,¹⁹ in 1910, put the time limit for antiluetic treatment at six or eight weeks at the most, while Rogers,²⁰ in 1911, says, "from three to six weeks is long enough to test the utility of antisyphilitic remedies," and Sachs,²¹ in 1920, puts the limit for palliative treatment at four weeks

Especially in children is it necessary to guard against losing valuable time

in the hope of giving relief by antisyphilitic medication Rivista²² found only one gumma in 140 cases of brain tumor in children, and in this case the child died after nine months of antisyphilitic treatment, which treatment did not seem to modify the gumma

Frazier, in a letter to the writer, says, speaking of gummata "In the first place, it is unimportant in the majority of instances to make a distinction, and in the second place, after you think you have made it, you probably find you have made a mistake, and an operation is often necessary to confirm diagnosis and to deal adequately with the lesion To make a diagnosis of gumma does not exclude it from the possibility of a surgical lesion " It is well to recall here the observation of MacEwen made at the International Medical Congress in 1909 to the effect that avascular gummata would respond to antiluetic treatment only after pressure had been relieved

It is well to recall here also the fact that decided remission in symptoms does not exclude brain tumor, nor does it indicate necessarily that the treatment used was the cause of the remission Abercombie, in his work on "Diseases of the Brain," published in 1843, relates the case of a patient who became blind rather suddenly, whose sight was restored by an emetic, but lost again, and permanently, within an hour Rudolf and MacKenzie, in the *American Journal Medical Sciences*, vol cxxxviii, pp 733-1909, report a very interesting case illustrating the extraordinary remissions that sometimes occur in patients with brain tumor

Ballance (*loc cit*) states the case about right, in my opinion, when he says "Decompression should be done before symptoms have become more than barely sufficient to enable a probable diagnosis of brain tumor to be made, one should never wait for pressure symptoms in the eye to develop " Cushing, in a recent letter to the writer, said "I have seen patients with syphilomas become blind during treatment for them I think a syphiloma is better treated like any other tumor "

Given a diagnosis of brain tumor the patient's interests are best served by an immediate operation, waiting for a complete diagnosis is dangerous If for any reason delay in a given case is desirable, the time of the delay should not be arbitrarily limited on the authority of any one, but rather the case should be carefully watched, especially the eye grounds, and the operation done before irreparable damage has occurred Then, too, the suffering which some of these patients endure may be, in and of itself, a sufficient warrant for a decompression operation Personally, I am in favor of the suboccipital procedure in subtentorial tumors, however, as Cushing²³ suggests, it is questionable whether a decompression here is any more effectual than one placed elsewhere For all other than subtentorial tumors Cushing's subtemporal operation is the one of choice, unless one desires to make some exploration in the hope of locating the tumor at the same time, in which case the operation may be planned along the lines advised by Hudson,²⁴ or the combined subtemporal decompression and exploratory operation described by Cushing²⁵

In 1902, and again in 1903, the writer ²⁶ called attention to the use of the exploring needle as an aid in locating tumors, abscesses and cysts of the brain through the change in resistance transmitted to the surgeon's hand as the needle progresses. Since this time I have frequently referred to this diagnostic aid in discussing the subject, but for some reason it has never come into general use. The hollow needle is quite frequently used in cysts and abscesses, but one rarely sees a report of the use of the solid needle in the way suggested. In a recent letter Doctor Cushing says "that needling for brain tumor is employed by all so-called neuro-surgeons." The evidence contradicts this statement, in so far as concerns the use of the solid needle in the way and for the purpose here advocated. *Die Hirnpunction* of Neisser and Pollack and Krause ²⁷ contemplates the use of a hollow, sharp needle, with its attendant dangers, for the express purpose of determining the presence or absence of fluid and for tapping the ventricles. The value of the needle in locating tumors and abscesses I have demonstrated, and Elsberg ²⁸ also has discovered tumors in this way, which he says "would otherwise have been missed." However, the reports of cases make it plain that many exploratory operations for brain tumor result in failure because this simple, safe and valuable expedient is not generally known and used. In 1912, Willy Meyer ²⁹ said in speaking of an exploratory operation for supposed cerebellar tumor, "The entire cerebellum was exposed and carefully explored with negative results. The patient died, and at the autopsy a large cyst was found in the left hemisphere, involving temporal and occipital lobe. Were it not that the sometimes dangerous consequences of aspirating the brain made surgeons fear the multiple use of the needle in intracranial operations, the cyst in this case might have been found and evacuated." I venture the assertion that this cyst might have been discovered by the use of the solid needle. Cushing, ³⁰ in his article on a combined exploratory and decompressing operation, cites two instances of tumor "too far below the cortex to be identified." It makes little or no difference how far below the cortex the tumor is situated so far as concerns its detection by the use of the needle. The detection rests upon the difference in resistance offered to the progress of the needle by the normal as compared with the abnormal tissue. Spiller ³¹ says "Deep probings where the tumor is not upon the surface are rarely of value and do harm." With the use of the solid needle the danger of "aspirating" the brain is eliminated, and from experience and study I am convinced that the procedure is relatively without danger and of great diagnostic value. The needle used should be long, slender, round, and rather dull. Elsberg has used a slightly roughened needle, and says by this means one is often able to recognize slight differences of resistance in the brain. I have not used a roughened needle in actual work but think the suggestion valuable, and shall act on it in the future. A fine trocar and canula, such as is used for intraspinal work, dulled slightly at the point and slightly roughened for about an inch at the distal end, makes an ideal instrument for exploring the

brain Coupled with the solid needle, one has also the canula in case he wants to tap a cyst or an abscess

The writer has experimented with such a needle by imbedding in a fresh brain pieces of liver and then locating them by the sense of touch as imparted through the needle He has also demonstrated the possibility of locating vessels and ducts in liver substance with the needle, and he ventures to suggest to neurologic surgeons who have not had experience with the solid needle for the purpose of locating tumors of the brain that if they will repeat these experiments they will be convinced of the value of the method

With two- or three-stage operations I have no experience, and like Cushing, I do not look upon them with favor However, it must be conceded that in some instances they become a necessity because of shock or hemorrhage or both, and in other instances advisable where one has failed to locate the tumor at the first operation in the hope that relief of pressure may make localization possible later on The necessity for a two-stage operation for simple decompression must be very rare It should be remembered, too, that some surgeons of large experience, like Von Eiselberg,³² prefer the two-stage operation for the removal of tumors, on the ground that it is safer for the patient

Drainage in this work should be looked upon as an evil which in some cases becomes a necessity When employed it should be removed in forty-eight or seventy-two hours Permanent drainage would prolong life and minimize the deformity in those cases in which it is impossible to remove the pathology However, I know of no reliable and safe way of accomplishing this G A Cathey³³ makes a tube of the dura and says that this "establishes permanent drainage," but I have not seen his original article and am unable to say upon what evidence his statement is based We do know, however, that, generally speaking, fascial tube drains are disappointing Halstead and Vaughan³⁴ say "X-rays, radium and fulguration practically do not come into consideration in the treatment of intracranial tumors" Later reports are more encouraging, however S Nordentoft³⁵ has a record of twenty cases of brain tumor treated by Rontgen exposures with encouraging results The favorable results in his "first series of eight cases have continued to date, there has been no recurrence of the growth or return of symptoms" Muskens³⁶ reports gratifying results from Rontgen-ray treatment in two cases of cerebellopontile tumor Frazier³⁷ reports three cases treated with radium, in which the "growth of the tumor, in the light of the clinical evidence, has been arrested at least, the tumor possibly destroyed in periods of observation covering a maximum of eight years" In one of Frazier's cases the radium was buried in the tumor, in the pontile angle, in one (also cerebellar) the tumor was not exposed and four applications of radium were made following suboccipital craniotomy In his third case the treatment consisted of combined use of X-ray and radium, together with pituitary and thyroid feeding following a sella decompression Williamson, Brown and

Butler,³⁸ as a result of experiments with radium upon dogs for the purpose of determining the safe dosage of radium, say that "the experiments give assurance that in brain tumors which respond readily to radium, little or no damage will be inflicted upon the brain tissue surrounding the tumor if the radium is implanted in the growth. The dosage can be regulated so as to be destructive only to the periphery." Unfortunately, Frazier found no case of glioma which seemed to be favorably affected by radium. On the whole, however, the later reports as to the effect of radium and X-rays on brain tumors are very encouraging.

CONCLUSIONS

- 1 The term "brain tumor" should include all growths of whatever origin or nature, either in or on the brain
- 2 Brain tumor is essentially a surgical malady
- 3 Surgical intervention should follow promptly the diagnosis of brain tumor. Postponement of operation for the purpose of locating the tumor or in the hope of getting relief through autolytic treatment or for the purpose of determining its character is seldom warranted. Better a comfortable, contented patient without a complete diagnosis than a dead patient or a blind one with one.
- 4 Exploration of the brain with a solid needle is a valuable aid in the localization of tumors and is free from danger if properly done.
- 5 X-ray or radium therapy should be used in all inoperable cases in which surgical removal is impossible, and after removal of malignant tumors.

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TUMOR OF THE BRAIN

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A SURGICAL APPROACH TO THE SPHENOPALATINE GANGLION*

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THAT there are certain pain phenomena of the face that are not attributable to lesions of the trigeminal nerve, no one will question. That some of these pain syndromes are relieved by cocaineization of the sphenopalatine ganglion I have demonstrated on many occasions. The sphenopalatine ganglion derives its sensory supply from the maxillary division of the trigeminal nerve but the conventional operations upon the trigeminal tract give absolutely no relief to these atypical neuralgias.

Since the sphenopalatine ganglion has intimate connection, through the large superficial petrosal nerve, with the sympathetic system, one wonders whether the pain of these neuralgias may be of sympathetic origin. There is nothing very speculative in this supposition, since in other territories there are painful conditions in the origin of which the sympathetic system is an acknowledged factor.

Attempts to relieve these neuralgias by alcoholic injection of the sphenopalatine ganglion, as proposed by Sluder, meet either with only partial success or with failure. Knowing the minute dimensions of the ganglion and the difficulty of access to it, one can readily understand why the results of injection are in many instances unsatisfactory and bear no analogy whatsoever to alcoholic injections of the divisions of the Gasserian ganglion. Having given much thought and time to the study of these neuralgias, presumably related to the sphenopalatine ganglion, I had rather reached the conclusion that unless a method for extirpation of the ganglion was at our command we had reached an impasse. Only by the extirpation of the ganglion in a series of appropriate cases will we be able to speak with any positivity, either as to the etiology or as to the treatment. If there is a clinical entity—call it Meckel's neuralgia if you will—the extirpation of Meckel's ganglion should be curative in effect, should it not?

Upon this assumption, therefore, my assistant, Dr. Francis C. Grant, and I have been at work in an attempt to find a way of approach to the ganglion which would make it accessible for purposes of extirpation. The approach we now present, I venture to hope, will prove a practical solution of this problem. In the two instances in which the operation was performed, there proved to be no inherent technical difficulties in gaining access to the fossa in which Meckel's ganglion is located. The anatomical landmarks (Figs. 1, 2, and 3) and the various steps in the procedure as portrayed in the illustrations (Figs. 4, 5, 6, 7, and 8) require little amplification in the text.

* Read by title at the meeting of the American Surgical Association, June 16, 1921.

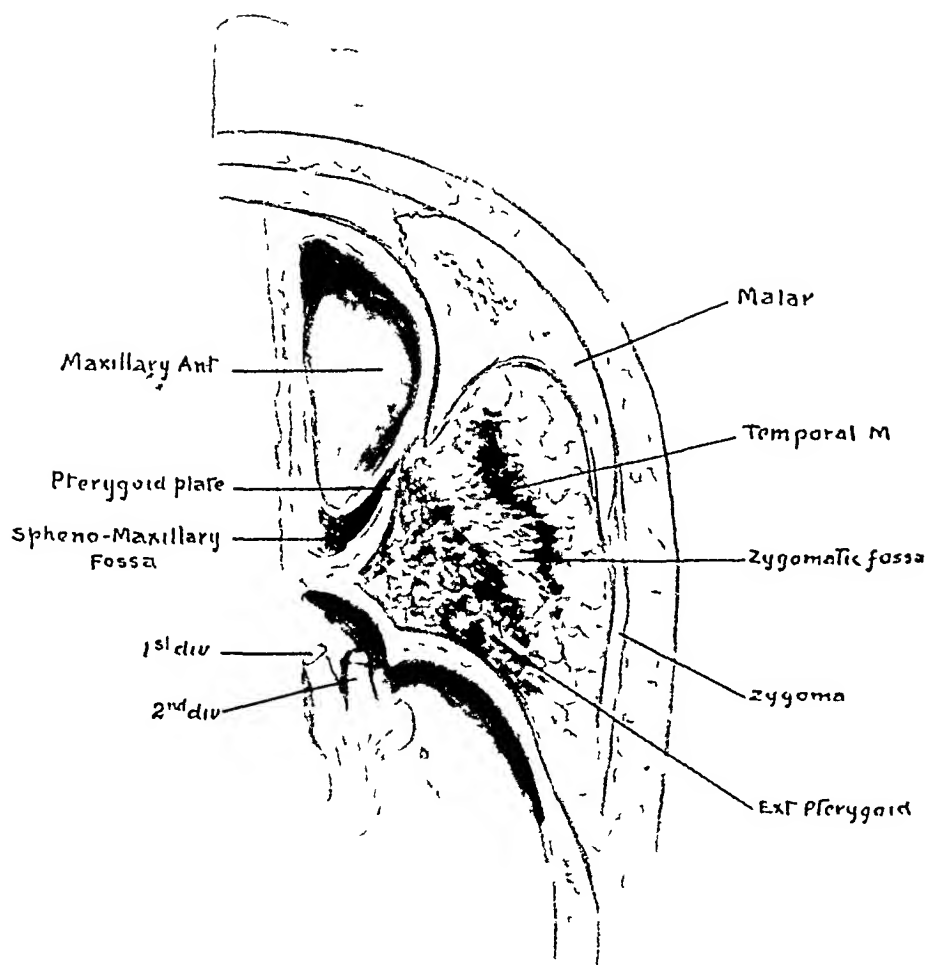


FIG 1 —Horizontal section

Anatomical relationship of the structures of the zygomatic and sphenomaxillary fossae

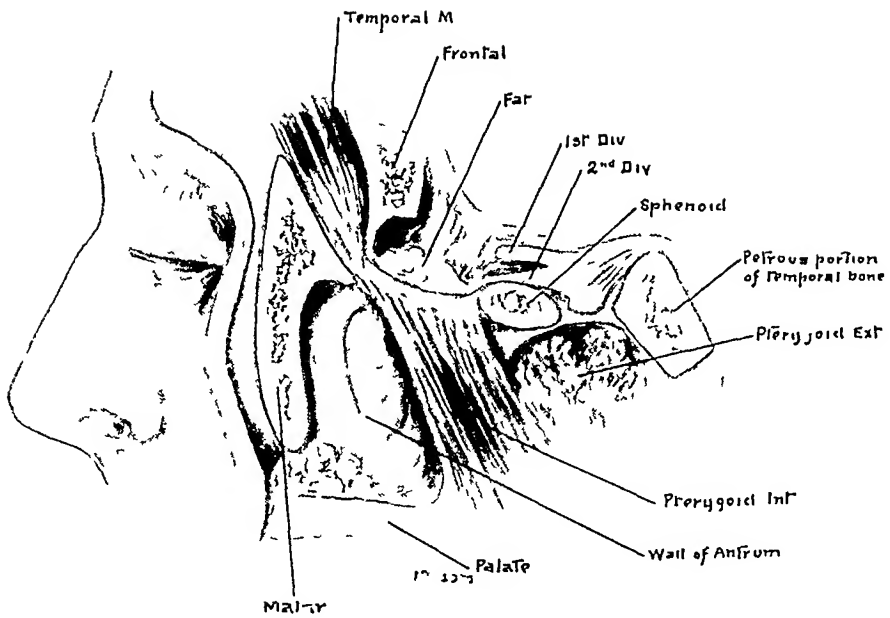


FIG 2 —Vertical section (a) Relationship of the structures in the zygomatic fossa

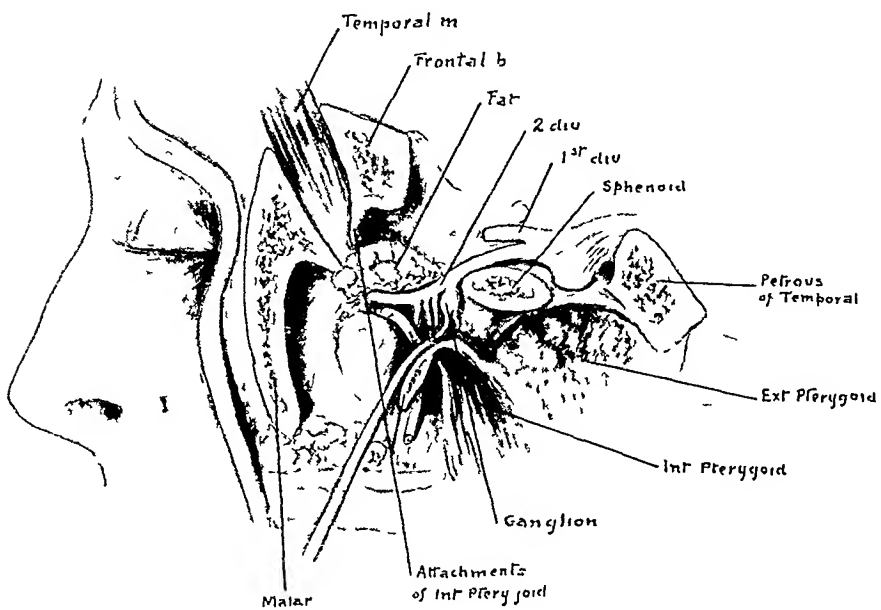


FIG 3 —Anatomical relationship of the second division and to the sphenopalatine ganglion in the sphenomaxillary fossa

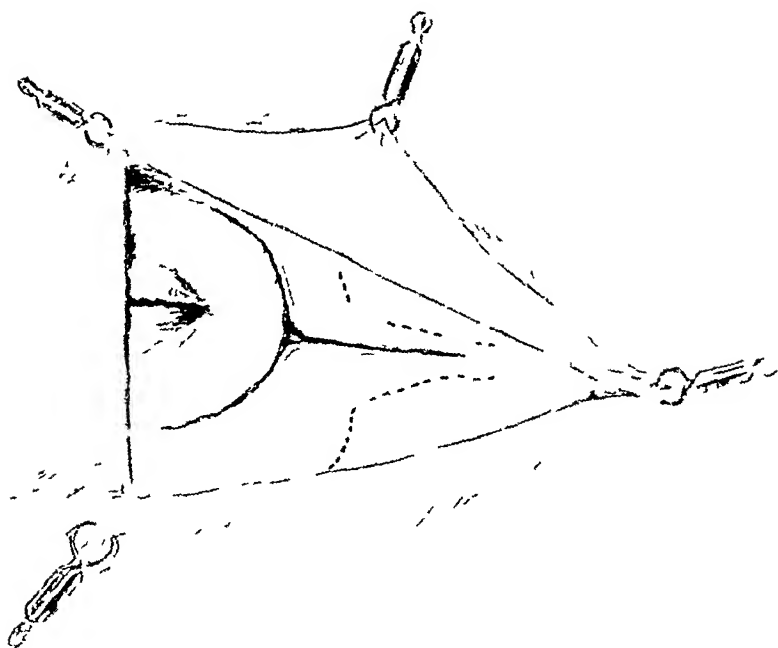


FIG 4 --The incision in relation to the orbit and the zygoma

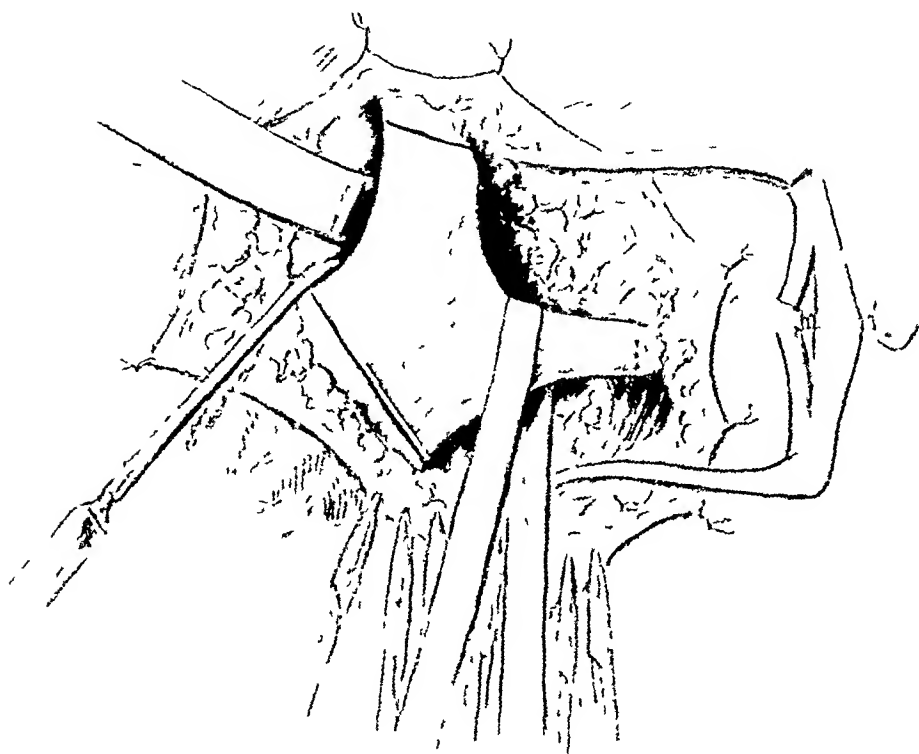


FIG 5 --The isolation of the zygoma and malar bone. (a) Malar bone, elevated above the orbit. (b) Dotted line represents the point at which zygoma is divided into two parts, the upper part being removed, leaving the outer portion in place.



FIG 6 —The Malar bone reflected backwards uncovering (a) The fat and muscle tissue in the zygomatic fossa (b) A portion of the orbital contents

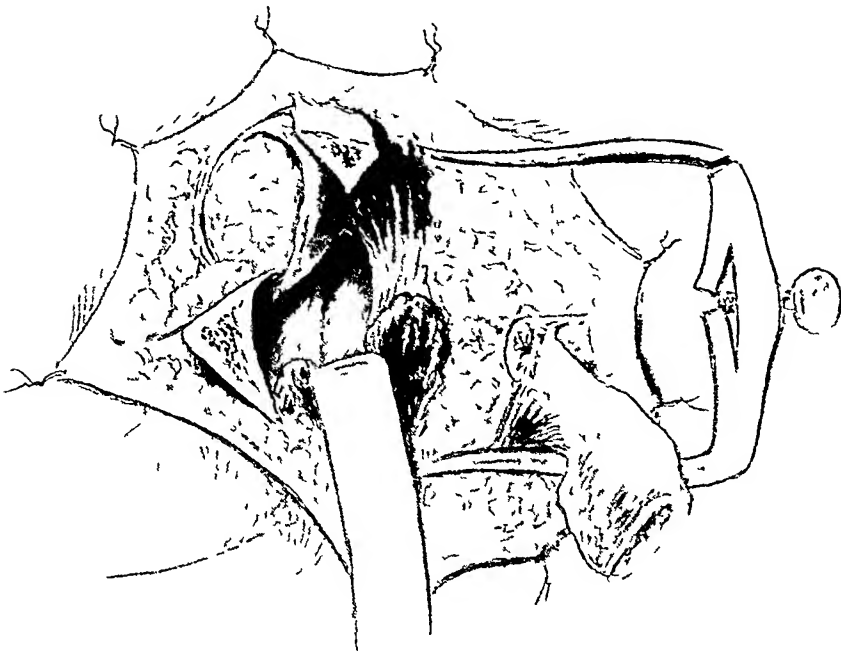


FIG 7 --(a) Temporal muscle is retracted downwards exposing wall of antrum (b) Internal pterygoid muscle above intact

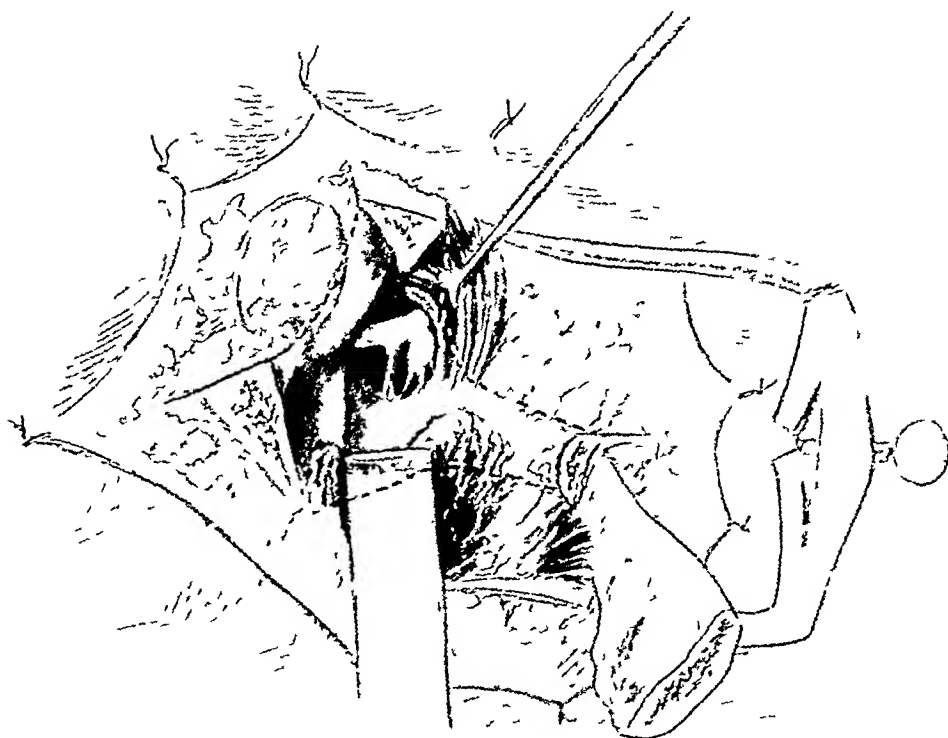


FIG 8—I The internal pterygoid muscle is displaced upwards II Pterygoid plate has been removed in part with rongeur forceps III The sphenopalatine foramen and the maxillary division of the trigeminal are exposed to view



FIG 9 —Photograph of patient after the author's operation for exposure of the sphenopalatine ganglion

SURGICAL APPROACH TO SPHENOPALATINE GANGLION

In the first three illustrations (Figs. 1, 2, and 3) will be seen the anatomical structures and relationships. The most direct route has been chosen as the most favorable and practical approach—a route that transverses first the zygomatic, then the sphenomaxillary fossa. To render accessible the zygomatic fossa the malar bone must be resected. Within the zygomatic fossa one encounters no obstacles not readily disposed of. All that one sees is a mass of areolar tissue, readily displaced, the posterior wall of the antrum, and the internal pterygoid muscle. To reach the sphenomaxillary fossa, in which is lodged Meckel's ganglion, a portion of the external pterygoid plate must be removed. Once within the sphenomaxillary fossa there are no structures to be seen except the maxillary division of the trigeminus, the artery that accompanies it, a mass of areolar tissue which surrounds Meckel's ganglion and its several branches.

STEPS OF THE OPERATION

I The incision (Fig 4) has been designed with due regard for its cosmetic effect and to avoid important branches of the facial nerve. There are three limbs, one straight, in the direction of the zygoma, and two curved, following the lines of the supra- and infra-orbital ridges. With careful apposition of the margins of the wound the healed scar is quite inconspicuous (See Fig 9). The branches to the orbicularis palpebrarum and the occipitofrontalis have not been disturbed.

II. Upon reflection of triangular flaps (Fig 5) the malar bone is exposed and with a Gigli saw three sections of the bone are made: (1) Through the frontal process, (2) through the maxillary process, and (3) through the zygomatic process. To make sections 1 and 2, the Gigli saw is passed through the sphenomaxillary fissure. At section 3 the zygomatic process is sawed only partly through, the outer shell and the periosteum being left intact. Thus an attachment is conserved which prevents any dislodgment of the malar bone when replaced at the completion of the operation.

III The malar bone reflected backwards (Fig 6) at once exposes to view the zygomatic fossa and its areolar tissue. One sees in the anterior portion of the wound the external aspect of the orbit.

IV A clearing of the contents of the zygomatic fossa is made now to expose the pterygoid plate (Fig 7). This is accomplished by following closely the surface of the posterior wall of the antrum and displacing backwards and downwards the areolar tissue and the temporal muscle. Before the pterygoid plate is exposed to view the internal pterygoid muscle must be detached.

V With rongeur forceps a portion of the pterygoid plate is removed and the contents of the sphenomaxillary fossa exposed. To find the sphenopalatine ganglion one should expose first the maxillary division, as it enters the orbit through the sphenomaxillary fissure, and follow it up to the ganglion. The ganglion itself is deeply placed in the sphenomaxillary fossa, close to the

sphenopalatine foramen Surrounded by fat it is not readily seen, hence the necessity of following the course of the maxillary division as a guide

Throughout the operation one does not see the internal maxillary artery One might have anticipated troublesome hemorrhage from this source, but such is not the case The only arterial trunk that one sees is the continuation of the internal maxillary artery in the infraorbital artery The space in which one works is comparable in size to that in the approach to the Gasserian ganglion and I have found my illuminated retractor, so satisfactory in the Gasserian ganglion operation, amply illuminates the field

ATROPHY AND INACTIVITY OF PAROTID GLAND, FOLLOWING OPERATIVE OBLITERATION OF STENSON'S DUCT, IN CARCINOMA OF THE CHEEK *

BY FRANK LEMOYNE HUPP, M D

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Efforts have been made, from time to time, to arrest the activity of the parotid gland or to reestablish by surgery the flow of saliva into the mouth, for fistula of Stenson's duct

While these efforts have been ingeniously devised and directed along experimental lines, and many important contributions, both surgical and non-surgical, have been made, the very fact of the multiplicity of the procedures seems to indicate the difficulty in selecting a method as the operation of choice

Deaver's³⁴ Surgical Anatomy describes the duct of the parotid as "running about a finger's breadth below the zygoma, or in a line drawn from the lower margin of the concha to a point midway between the free margin of the upper lip and the ala of the nose. It lies between the transverse facial artery above and the buccal branch of the facial nerve below. The duct runs over the masseter muscle, turning abruptly inward at its border, passes through a mass of fat overlying the buccinator muscle and beneath the facial vein, and pierces the buccinator muscle, to open into the mouth opposite the crown of the second molar tooth of the upper jaw"

The etiology of salivary fistulae is well known, how they may develop as a result of a trauma, or from faulty technic in the removal of a neoplasm, the opening of an abscess, or as a sequel to flap excision in facial autoplasty

Salivary fistula may follow a destructive process due to carcinoma, lupus, rodent ulcer, actinomycosis, or syphilis, or from a pressure necrosis and infection arising from salivary calculi

Agnew³² describes a congenital salivary fistula in which the opening was on the anterior part of the helix of the auricular cartilage

Mauclaire²³ reports eleven cases of duct fistula following dental abscesses, and three associated with the presence of foreign bodies, as wood and lead

Schreiber²⁸ introduces a new etiologic factor, reporting a salivary fistula following a simple mastoidectomy. Such a misfortune, of course, coming from the parenchyma of the gland, demonstrates how this subject should seriously engage the attention of the operator who would deal with a tumor, phlegmon or mastoid

An interesting factor with a definite bearing on the end result in the repair of a salivary fistula has been suggested by Tait,²⁹ whose original work in this field has won for him distinction. The normal length of the duct of the parotid is about 6 cm and 0.3 cm in diameter. The oral third contains the same bacterial flora as may be found in the mouth, hence it can be definitely seen that this source of infection offers an additional factor against successful surgery, particularly if there is any oral pathology

* Read before the American Surgical Association, June 14, 1921

The possibility of the relief of a salivary fistula coming through the obliteration of Stenson's duct by ligature was first suggested by Dupuytren,¹⁵ accepted by Velpeau, and practiced by Viborg and Bramann, but their efforts were far from successful, due chiefly to the development of retention salivary cystomata, or infection with abscess formation

CASE REPORT—G W, a man aged fifty-eight, was admitted to the writer's service in the Ohio Valley General Hospital in February, 1912, suffering with what seemed to be epithelioma of the right cheek. In the centre of the ulcer there was a salivary fistula. Extending out from the circumference of the ulcer there was a large area of cicatricial tissue, which was the seat of a dermatitis and otherwise devitalized from the overzealous use of caustics, pastes and Rontgen-therapy.

Luetic infection was definitely excluded, and on section the unhealthy neoplasm proved to be a cancer. There was no glandular involvement and otherwise the patient's health was good.

In planning the operation for the removal of the malignancy, the question of sidetracking the secretion of the parotid presented obvious embarrassment, due to the apparent destruction of a large part of the buccal portion of Stenson's duct. Flaps were designed by horizontal H-shaped incisions, radically removing the pathology, without involving the mucous membrane of the mouth. Further dissection and retraction of the posterior flap exposed the remnant of the masseteric portion of the duct, but the short proximal end precluded the possibility of following any of the operations suggested for diverting the flow of saliva into the mouth. Ligation of the duct with the chances of leakage, infection or cyst formation, with the probable defeat of the plastic repair, was not deemed wise. The remaining part of the duct was crushed with an angiotribe as far back as possible, and this short ribbon was brought through a stab-incision in the posterior flap onto the cheek and sutured to the skin.

The sole apology for this step in the technic was the hope entertained that one of two things might occur—either that the secretion of the parotid might find a new outlet far removed from the reparative work, or, however inconsistent, a happier result might be attained in the complete suppression of the physiological activity of the gland.

The skin wound was closed with horse-hair, and provision for drainage was effected by a stab-wound beneath the inferior maxilla, carrying a narrow rubber band.

The wound healed without interruption, there was at no time any further discharge of saliva from the obliterated duct, and there was an absence of any phenomenon of retention, or painful tension on the part of the gland.

Our reason bids us assent to the accomplishment of a fact, namely. The inactivity and atrophy of a gland following the operative obliteration of its duct, but the question may be raised, did the hoped-for changes in the histology of the parotid come as a result of our aid, or in spite of it?

Any further detail of the progress of the carcinoma, with the sequence of events, is not germane to this report, suffice to say that for almost three and a half years there was no sign of recurrence. But after that time the cicatricial tissue of the cheek, devitalized and scarred by repeated preoperative Rontgen-therapy and other remedial measures, offered little resistance to a rekindling of the disease. Despite the most skilfully applied X-ray cross-firing, radium, and electro-coagulation, the cheek, bone and meninges, in slow succession, yielded to the devastation, with the inevitable *exitus lethalis* in February, 1919. There was no autopsy.

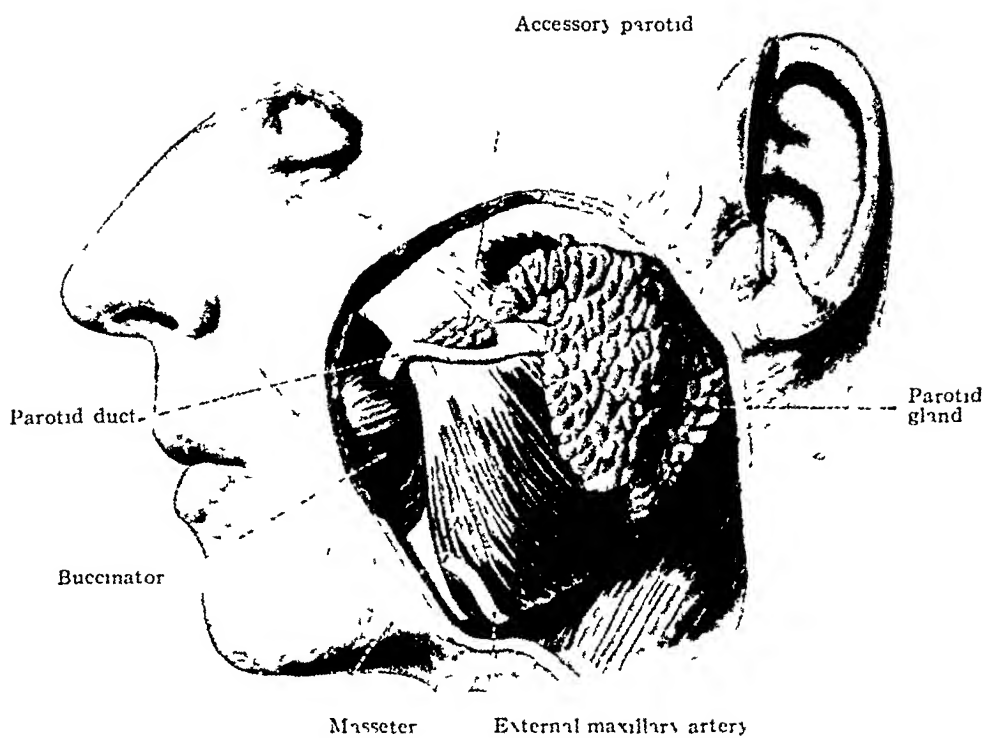


FIG 1 —Parotid Gland and Stenson's Duct
From Sabott's Anatomy W B Saunders Co

ATROPHY AND INACTIVITY OF PAROTID GLAND

COMMENT ON CHANGES IN THE GLAND

Very little has been written of the changes occurring in the parotid gland and its secretory function following operative obliteration of Stenson's duct. It is obvious that the subject needs further experimental investigation before we can depend on atrophy or involution taking place following this procedure.

Pietri's²⁶ observation leads to the assumption that atrophy comes about very slowly, this is particularly true following a non-infected fistula, while quite the contrary is the rule in cases of parotitis consequent upon traumatism, when the inactivity of the gland is rapid and permanent. In most of Pietri's cases the glandular tissue became sclerotic, adhering firmly to the tissue framework which before had acted as a support pure and simple. But this is an hypothesis, which the writer seems to think may be verified by the histologist.

In a personal communication from Frederick S. Lee, of the Department of Physiology of Columbia University, he found an account of some investigations by Maximow, in which in a dog the duct of the submaxillary gland and the duct of Bartholin (the chief duct of the sublingual gland) were ligated, and the dog was killed after thirty-one days. The ducts on the gland side of the ligature were found enlarged and filled with thick saliva. The glands themselves were considerably diminished in size, although the interlobular connective tissue appeared strongly hypertrophied. Microscopic investigation showed results very similar to those after section of the chorda tympani. There was apparently a paralysis and final disappearance of the mucous cells, while the serous cells, although changed, remained and continued to secrete.

Perhaps Cole's⁷ suggestion may prove helpful, following the obliterative operation, in the use of radium or X-rays as a post-operative measure, in those exceptional cases where the transplanting of the duct is impossible.

Doctor Burnam, of Baltimore, in a personal communication, has described the changes in the parotid gland after radiation as striking, and quite different from those occurring in the ovary. All of the salivary glands a few hours after radiation swell enormously, and the patient presents the appearance of mumps. There is a cessation of saliva and consequently a drying of the secretions of the mouth, which lasts from a few days to two weeks after such treatment. This tendency to parotitis is the first change. If a tremendous amount of radiation is given there is gradual atrophy of the parenchyma of the glands, however to accomplish this a very large treatment must be given. The parenchyma is replaced by proliferating fibrous tissue.

REVIEW OF THE LITERATURE IN THE TREATMENT OF SALIVARY FISTULA

Pietri gives a résumé of the various early procedures, including the compression of the gland by Maisonneuer, caustics and agglutinants and the gold plate of Malgaigne. It is needless to say that these were of little efficacy and had their day, as did also compression of the carotid and ablation of the gland. The author speaks of the work of Molliere, of Lyons, who in 1884 endeavored to cause atrophy of the parotid by the injection of phenolated oil,

and how Cocchini gave preference to turpentine for the same purpose. These efforts are of interest historically, but are deserving of no comment.

Of the older operative procedures the one planned and successfully executed by DeGuise, and bearing his name, has been commonly accepted the operation of choice. It consists of the excision of the discharging sinus in the cheek, and the transfixation of the buccal mucous membrane at two points with a needle carrying either silk or wire. The ligature is tied in the mouth, and the seton effect with the consequent necrosis turns aside the parotid secretion in the natural direction.

This procedure is usually successful in the simple non-infected fistula, but, as so often happens, the discharge of saliva comes from a cancerous ulcer, which has destroyed a large part of the duct, and the removal of this malignancy becomes necessary by radical excision, before any thought can be given to the aberrant salivary flow. It is reasonable to infer that under these conditions it would be difficult to successfully employ any of the older methods, like the operations of Nicolandi, Langenbeck, Kaufman, or the ingenious oroplastic technic of Braun.

REVIEW OF EXPERIMENTAL WORK

Ferrarini's¹⁶ work included a series of operations on dogs, which were interesting. On one side simple ligature and resection of Stenson's duct was done, on the other side ligature of duct and suture of parotid and submaxillary glands. After three months he dissected out Stenson's duct and injected colored gelatine into the central end. On the side where the gland had been united the gelatine passed from the parotid into the submaxillary. In dogs long operated the inflow was so easy that the gelatine could be made to pass out of Wharton's duct and vice versa.

Histological examination of several sections showed that an intimate union had taken place between the glands of the one side, on the other side the glands showed typical atrophy processes, whereas the parotid which had been joined to the submaxillary had preserved its form, volume, and for the most part its structure unchanged.

The operation on man—done only on the cadaver—is described as free from difficulty. The usual section for submaxillary removal is made, being carried about 2 cm. further upward and backward along the border of the vertical ramus of the mandible. The submaxillary capsule is incised and the gland completely mobilized. Behind the angle of the mandible the lower end of the parotid lobe is isolated, and, when necessary, the small aponeurosis between the angle of the mandible and the anterior border of the sternomastoid is divided. The glands are then easily approximated over a wide area. A small part is removed and the cut edges sutured, the parenchyma and the capsules being joined separately. Ferrarini expects the operation will be clinically successful in stubborn cases of duct fistula.

Tait³⁰ conducted three sets of experiments on dogs, cats, and rabbits. The first set consisted in double ligation and resection of 1 cm. of Stenson's

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duct in either the inner, middle or outer third, the resected tissues being tested bacteriologically in each case, the second set consisted of ligation of the duct without resection, in the third set a double fistula was made in the outer third and then treated by double ligation and section of the duct in its inner third. From the results of these experiments he reaches the following conclusions

"Atrophic sclerosis of the parotid gland follows obstruction of Stenson's duct

"Its extent is in direct proportion to the degree and duration of obstruction

"The addition of an element of infection may hasten the hyperplastic process

"Distention of the duct may persist long after the gland has undergone almost complete fibrous atrophy

"Fistula of Stenson's duct may be permanently cured by double ligation and section of the duct as close as possible to the gland

"Operations on the bacterially rich outer third of Stenson's duct are much more frequently followed by fistula than are similar interventions on the inner third of the duct

"The effects of incomplete obstruction or stenosis of the salivary ducts are frequently found in the parotid and submaxillary glands, where, by simulating malignancy, they may lead to grievous mistakes in surgical therapy"

SURGICAL TREATMENT

The article by Dieulafe¹³ and Pietri²⁰ in the *Annals of Otology*, December, 1918, reviews some of the earlier methods of treatment. The Paris Thesis, by Rousseau,²⁷ included in the Bibliography, gives no additional data of importance.

Aigrot¹ presents an interesting discussion of the rôle of the auriculo-temporal nerve, and a report of the anatomical studies on its distribution in the ox, horse, pig, sheep, dog, and man, with a description of Leriche's procedure and the indications for its use.

Benedict² gives the history of a case of gland fistula caused by syphilitic abscess. The external opening was freshened and sutured, with recovery.

Berteaux³ reports the case of a girl of eleven who had had a duct fistula for seven years because of an incompletely healed wound from a dog bite. The duct anterior to the fistula was not viable, and he concluded to lead the central portion into the mouth cavity. It was dissected out for about a centimetre. An opening was then made through the cheek and two linen threads attached to the end of the freed portions of the duct were passed through the opening. The threads were then sewed into the lips of the buccal wound. The suture was made so as to maintain the opening of the duct. The external wound healed in twelve days and the patient was discharged eighteen days after the operation, with a buccal fistula functioning perfectly.

Carwardine⁵ dissected out the branches of the facial nerves which pass through the parotid. These were held up with catgut and the whole gland removed. He used small sharp scalpels. There was temporary facial paralysis, but in a couple of months there were twitchings, and in four months some movement. A year afterward the patient had good control of the facial muscles and very little difference between the two sides was apparent.

Cole⁶ treated two cases by an ingenious reparative operation. The general principle adopted in this operation was that "if the duct will not reach the mouth cavity, the mouth cavity must be made to reach the duct." A curved incision was made with convexity down, and a small flap resected upwards, this revealed the duct, and a small lateral hole in the duct marked the limit of patency. The duct was freed, its terminal portion resected, and two very fine catgut traction sutures were passed through its walls. The mucous membrane, covered by buccinator, was then made prominent immediately in front of the masseter by means of a small swab pressed against it from inside the mouth, and a small longitudinal incision was made through it into the mouth. The masseter was nicked at its anterior border and the margins of mucous membrane stitched to the deeper margins of the wound. Through the aperture thus made the stay sutures were passed and the duct was gently pulled into the funnel-shaped extension and the extension cut off from communication with the exterior by catgut sutures. The skin was sewed up, drainage through a small stab incision. Each stay suture through the duct was then made to take a good hold of mucous membrane inside the mouth, so that when tied the duct was secure in place. In both cases slight supuration with discharge of saliva occurred about the tenth day, but communication with the mouth was well established and good healing occurred in a few days. Both cases were discharged cured in three weeks.

Hamilton²⁷ operated on a patient with a fistula of several years' standing, enlarging the opening, and curetted out from a cavity the size of a hazel nut "some starchy gelatinous secretion, together with shell-like fragments of calculous material" lining its wall.

The anterior part of the duct was not visible, the posterior part very short.

A hæmostat was forced from the cavity through the gland and the mucous membrane cut over the point of the forceps. The channel thus formed was enlarged by opening the forceps widely. A flap was cut one-half inch wide at the base just anterior to the artificial buccal opening and tapering slightly to its tip, which was posterior to the angle of the mouth. The flap was slightly less than one-eighth inch deep. The hæmostat was again pushed through the channel and the tip of the flap seized and drawn into the fistula cavity, the mucous membrane being superficial. It was sutured to the gland surface by three fine silk sutures. The external margins were pared and sutured and the buccal mucous wound sutured. A rubber drain was inserted into the new opening. Complete cure.

Jennings²⁸ described a razor cut with subsequent scar which caused occlusion of the duct and collection of saliva in tumor-like lump under the skin. A cyst-like cavity at the edge of masseter muscle was found. A bougie passed from the mouth one and a half inches up the duct which was severed. A rubber tube was inserted into the severed end and also into the central end which opened into the cavity. A continuous chromic gut suture was put in so as to obliterate the greater part of it, the skin wound left open, dressed with sterile gauze and sealed with collodion. The wound healed in about two weeks. The tube was in place on the tenth day, on the eighteenth day it had disappeared. The duct was patent two months after operation.

Leriche²⁹ reported a case in which he abolished the physiological activity of the parotid by avulsion of the auriculo-temporal branch of the inferior maxillary nerve (Fig 2). Dieulafe,³⁰ in his endorsement of Leriche's operation, mentions eleven cases in which this method was successfully employed.

The operation is comparatively simple, but it must be remembered that it does not always result in an immediate cessation of the flow of saliva. In the cases reported, in only one was the cessation immediate, in all others two to

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eight days elapsed, in most cases five to six days, before the secretory activity of the parotid and the flow of the saliva ceased entirely

Weitz²¹ reports one case in which the fistula had persisted for more than twenty years, treated by Leriche's method. The salivary secretion ceased at once, and did not reappear. He notes also Tromp²² had operated on three cases successfully by this method.

Cole⁷ condemns Leriche's operation, comparing it to the plumber who would repair the leaking pipe by cutting off the water supply of the house.

Mothersole²³ reported a patient who developed a fistula after an operation for removing a neoplasm. The amount of scar tissue surrounding the opening excluded most methods of operating, so the author dissected up a strip of mucous membrane one and one-quarter inches long and one-third inch broad, with its long axis horizontal and its front end near the mouth of the parotid duct. He then bored a hole through the cheek just in front of the fistula and dilated it so that the flap could be brought through the opening. He then dissected up the surface of the scar on the cheek, and removed all but a small collar of tissue surrounding the fistulous opening above, behind, and below. To this he attached the free end of the flap by a few interrupted catgut sutures. This

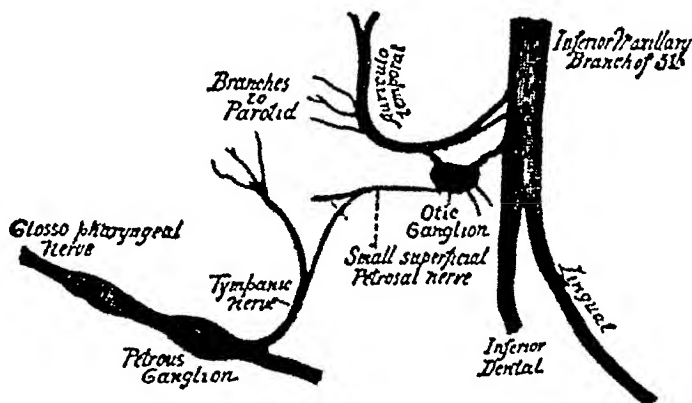


FIG 2—Leriche divides the auriculo temporal branch of the inferior maxillary division of the fifth cranial nerve in his operation for fistula of Stenson's duct.
From Howell's Physiology, W. B. Saunders Co.

made an epithelium lined track from the parotid gland to the mouth cavity. He dissected from the neck, just below the horizontal ramus of the jaw, a flap of skin left attached at its posterior part, rotated it through a quarter circle and covered the raw surface on the cheek with it. The gap left was closed by interrupted sutures except a small triangular bit at its widest part. The wound had healed in a fortnight and all the parotid secretion passed into the mouth. Sixteen months later a probe passed easily through the duct.

NON-SURGICAL TREATMENT

Cole⁸ contends that fistulae of the gland and incomplete fistulae of the duct tend to heal without treatment. If treatment is delayed the application of radium or X-rays is indicated. He writes "Gland fistulae and incomplete fistulae of the duct have never failed to respond to radiations."

The radium treatment consists in exposures to a penetrating radiation from 250 mg of radium in platinum tubes of a thickness of about one-half mm. 3 mm of lead were also used to cut off the hard Beta rays, tubes enclosed in rubber and several layers of lint were used on the skin. Exposure of three to four hours was given each skin area, those with considerable induration of tissue

receiving a longer exposure than others. In a number of patients X-rays were combined with the radium, small doses being given at short intervals, a 2 mm aluminum filter being used.

The title of Koundjy's¹⁹ article indicated treatment of salivary fistulæ by massage and the application of hot air. The original article was not available.

Moreau²¹ treated one case with silver nitrate and iodine alternately. Care was taken that the orifice was not closed too quickly. The treatment was satisfactory after a month.

Pietri²² thinks that rather than change the course of the saliva by surgical procedure, it would be more logical to try to lessen its production by absolute rest. Through the agency of what he calls a mask, which is not unlike the Barton bandage, he immobilizes the jaw, at the same time suppressing all gustatory sensation, enforcing a liquid diet for several weeks, with tube feeding and imposing on the patient absolute silence. Thirty-eight cases were successfully treated by this method.

The original of Stropeni's²³ article is not available, but according to the abstract in the J A M A, 75 138, 1920, his treatment consisted of blocking the third branch of the trigeminal nerve by injecting alcohol. This proved as efficient in curing the flow of saliva from a fistula as resection of the auriculo-temporal nerve recommended by Leriche. He injected 3 cc of alcohol at the base of the skull, corresponding to the foramen ovale, and repeated this injection three days later. The fistula continued to suppurate, but there was no further secretion of saliva in the gland.

Koundjy²⁴ describes his method of treating salivary fistula, as illustrated in one case of a soldier with a fracture of the mandible, badly consolidated, and a salivary fistula of the left side of the jaw. The treatment was begun "by massage, superficial, and deep rubbing, and centripetal vibrations from the periphery to the centre, not touching the fistula. At the same time the facial cicatrix was massaged * * *. All of the massotherapeutic manoeuvres were executed first without hot air, later by a current of hot air over the entire cutaneous surface of the jaw and the fistula itself. Finally the current of hot air was turned upon the buccal surface, through the opening of the mouth, in such a way as to bring it in contact with the internal border of the fistula." In order to avoid burning or pain, the application of hot air was interrupted every two or three seconds (Temperature of air, 37° to 30° C). The treatment was begun August 20, 1918, improvement was noticeable by September 26th, and the fistula was completely obliterated by December 17th.

The action of massage and hot air on the fistula, Koundjy explains as follows. The hot air causes a hyperæmia that induces a local change that may be compared to a caustic action. In addition it has an analgesic action on the tissues and causes progressive drying of the secretions. This last effect can be compared to resection of the auriculo-temporal nerve. The action of massage is mechanical and reflex. The mechanical action has a favorable effect on the circulation and the reflex action on the terminal nerves. It also increases the nutrition of the tissues.

From this study and out of the abundance of an interesting literature, including experimental, surgical and non-surgical, we may briefly conclude:

- 1 That by crushing the duct of the parotid there may follow histologic changes leading to an atrophic sclerosis, with suspension of the activity of the gland.

- 2 It is fair to assume that this condition is influenced by the use of radium alone or combined with the X-rays, resulting in a replacement of the gland by a proliferating fibrous tissue.

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3 Further experimental evidence is wanting before we may depend on operative obliteration of the parotid duct to arrest the flow from a salivary fistula

4 Fistula of Stenson's duct has been permanently cured by double ligation and section of the duct as close to the gland as possible (Tait)

5 Leriche and his followers have arrested the physiological activity of the parotid by avulsion of the auriculo-temporal branch of the inferior maxillary nerve

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AN ANALYSIS OF 102 CASES OF TUMORS OF THE BREAST*

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THE American Text-book of Surgery, published in 1903, states that "about 83 per cent of all mammary tumors are carcinomata, while the remaining 17 per cent are sarcomata, adenomata and cysts" In 1911 my son, Dr Nathan Winslow,¹ and I, tabulated a series of 100 cases of lesions of the breast, occurring in the University Hospital, Baltimore, with the following result: sixty-three were carcinomata, three sarcomata, twenty fibro-adenomata, one peri-canalicular myxoma, five cystic fibro-adenomata, two galactoceles, three tubercular mastitis and three abscesses Of these ninety-nine were females and one a man, with a fibro-adenoma Eighty-eight were of the white race and twelve of the colored

The question of the incidence of carcinoma in comparison with all other tumors of the breast seems still to be unsettled, thus Finney² places the proportion as 80 per cent cancer, A P C Ashhurst³ as 70 per cent malignant and Da Costa⁴ says malignant tumors of the mammary gland are ten times more common than innocent tumors Dr Miles F. Porter,⁵ writing in 1919, says that of seventy-seven cases of neoplasms of the breast observed by him personally, forty-nine, or 63.63 per cent, were malignant and twenty-eight, or 36.37 per cent, were benign On the other hand, Bloodgood⁶ gives the percentage of benign to malignant lesions of the breast, as observed at the Johns Hopkins clinic, as gradually rising from 32 per cent, in the first decade after the opening of the hospital, to 59 per cent in the three years immediately preceding his report; and thus he attributes to the education of the profession and the public, through which patients are referred to the clinic at an earlier date than formerly.

As this statement is at variance with the usually accepted opinion, we have gone over the records of the University Hospital for the three years 1917, 1918 and 1919, to ascertain if there has been any material change in the statistics of breast lesions as they have been observed in this particular institution since the publication of our report in 1911. During these three years 102 patients were admitted to the hospital, with lesions of the breast of various kinds Of these sixty-one were carcinomata, three sarcomata, eighteen benign solid growths and twenty benign cystic growths Ninety-nine were females and three males Of the women ninety were white and nine colored The men were white and had non-malignant neoplasms Eighty-eight were married ten single and in four the social condition is not recorded. The left breast was involved in fifty-six cases, the right in forty-four, not mentioned two Both breasts were involved in one case, the lesions being benign Ninety-two cases were subjected to operation, of whom three died; one of

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pneumonia, one myocarditis and one acute dilatation of the heart Six cases were inoperable and three refused operation Fifty-nine and eight-tenths per cent were carcinomata, 2.94 per cent sarcomata and 37.26 per cent benign The length of time that elapsed between the discovery of a tumor by the patient and the application to the surgeon for relief varied from one week in two cases to forty-nine years in one, the largest number of cases coming under surgical care at the end of one year The ages of the patients varied from nine years, in the case of a negro girl who was operated on under a diagnosis of fibro-adenoma, to seventy-two years in two cases of carcinoma

Carcinoma—The cases of carcinoma were sixty-one in number, or 59.8 per cent The largest number of cases came under observation in the fifth decade of life Six occurred before thirty-five years of age and two between twenty and thirty The youngest was twenty-three years old, and was operated on under the diagnosis of fibro-adenoma, but the pathological report was "cystic papillo-adenoma, undergoing early malignancy" Among the cases tabulated in our previous report was that of a girl of seventeen, with a fibro-adenoma undergoing malignancy Two women, aged seventy-two, were operated on, one dying in about three weeks with myocarditis and the other died a year later with a recurrence

The carcinomata were subdivided into simple carcinoma twenty-eight, scirrhus eighteen, scirrhus with colloid degeneration one, scirrhus with hyaline degeneration two, medullary one, adenocarcinoma three, cystadenocarcinoma one, cystic papillæadenocarcinoma one, cystic carcinoma one, suppurating carcinoma one Fifty-seven of the women were married, two single and two not stated The right breast was involved in twenty-seven, the left in thirty-three cases

The tumor was located in the upper and outer quadrant in twenty-two, upper and inner four, lower and outer four, lower and inner one, central three, general eight, the rest not recorded For some reason unknown to me the cancerous growth is generally located in the upper and outer quadrant In my personal experience cancers situated in the upper and inner quadrant are much more unfavorable as regards permanent cure than those located on the axillary border

In January, 1917, a lady, aged forty-eight, consulted me for a lump in the upper and inner portion of the left breast The growth had been in existence six years and had increased rapidly during the preceding six months There were marked axillary metastases A radical operation was done and she made a speedy recovery One year later she returned with a considerable mass in the sternum, opposite the second and third costal cartilages I excised a considerable portion of the sternum, with the overlying tissues, leaving a large square hole leading into the anterior mediastinum The internal mammary artery was cut and bled freely before it could be ligated and the left pleural cavity was opened and air sucked in She developed an empyema, which was drained posteriorly, and she recovered, but died in November, 1919, of general carcinomatosis

In October, 1917, a colored woman, aged forty-two, appeared with a fairly movable tumor, as large as a hickory nut, that had been noticed about six weeks. This was also located in the upper and inner periphery of the left breast and was supposed to be an adenofibroma until a frozen section revealed it to be a carcinoma. The breast, muscles and axillary glands were removed. In the summer of 1919, she returned with a metastasis, very similar to the one mentioned above, in the sternum. She elected to try radium, under the application of which the swelling subsided somewhat. She is still alive but is failing rapidly.

The growth was stated to have been adherent to the skin or muscles in forty cases and in only ten was it recorded that it was not attached to either.

The axillary glands were recorded as not palpable in three cases and in two the supraclavicular glands were to be felt. Duration of the tumor—three weeks one, seven weeks one, two months three, three months three, four months three, five months two, six months four, seven months one, eight months one, nine months one, ten months one, one year five, one and a half years one, two years three, six years three, ten years one, twelve years one, twenty years one, twenty-two years one, forty-nine years one.

Many more married than single women have cancer of the breast, but this depends more on fecundity than on the social condition. Trauma also seems to play only a small part in the production of cancer of the breast, and in only four cases was there any history of an injury.

Pain, also, is not a frequent concomitant of mammary cancer, and in only a few of our records is it stated that pain or tenderness were present.

One woman had had bleeding from the right nipple intermittently for one and one-half years. The nipple is stated to have been retracted in twelve cases, not retracted in eleven, and stiff in one.

There were six cases of carcinoma of the breast in negro women. It is a mistaken idea that negroes are to any large extent immune to cancer.

Metastasis to the skeleton is only occasionally observed and the only bone involved in this series, except the two in which the sternum was the seat of recurrence, was the ilium. When remote metastases occur the usual locations are the spinal column, the femur or the humerus.

Sarcomata—There were three cases of sarcoma, or 2.94 per cent. They were all white women and married. Their ages were twenty, fifty-four and sixty-three. One had been in existence two years and one only two months. In all the left breast was affected.

The pathological classification was sarcoma one, myxosarcoma one, fibromyxosarcoma one. No metastases were mentioned in any of these cases. Radical removal was done in all, except that in one case the pectoral muscles were not ablated.

Non-malignant—There were thirty-eight cases of non-malignant tumors, or 37.26 per cent. Women, thirty-five, men, three, white, thirty-six, colored, two. Twenty-seven were married and eight single. The ages ranged from nine to sixty-six years. The right breast was affected in sixteen cases, the left in twenty-one, and in one both breasts were involved. The location of the

growth is stated in only sixteen cases, and of these, eleven were situated in the upper and outer quadrant. The size of the tumors varied from that of a pea to that of an egg or lemon. Three cases had had tumors of the breast removed previously. The lesions were classified as follows: Fibro-adenomata fifteen, of these two occurred in males aged thirty and forty-two, respectively, fibromyxoma one, in a male aged sixty-six, intracanalicular fibroma, one, cystic fibro-adenomata, twenty, chronic hyperplasia, one.

Two cases were operated on under the supposition that they were adenocarcinomata, but the microscopical examination showed them to be fibro-adenomata. A negro girl, nine years old, who had a considerable enlargement of the left breast, but not of the right, was supposed to have a fibro-adenoma and the breast was amputated, but the pathological report was "chronic hyperplasia."

In only two cases was there a history of trauma. Most of the tumors were freely movable and there were no glandular metastases. Pain was absent in most cases, but in one attention was first called to the breast by pain, when a lump was discovered. The time the tumor had been noticed by the patient before coming to the hospital for treatment varied from one week to five years, only six being recorded as having been less than one year in existence.

CONCLUSIONS

1 From a consideration of these and other cases, and from the published statistics of other writers, I am still of the opinion that carcinoma is the predominant neoplasm of the mammary gland and that it occurs in from 60 to 65 per cent of all mammary tumors.

2 While it is probable that breast tumors are coming under observation earlier than was formerly the case, nevertheless, in the hospital with which I am connected there has been no marked difference between the time at which this series of cases came under surgical care and that of the series collected in 1911.

3 Sarcoma occurs in about 3 per cent of tumors of the breast. This condition is malignant and should be treated in as radical a manner as a carcinoma.

4 Non-malignant neoplasms occur in about 35 per cent of all cases. In my opinion no woman should be allowed to harbor a neoplasm in her breast, whether it be benign or malignant, or whether she be young or old. Sooner or later benign tumors tend to become malignant, and the time to remove them is while they are still benign. One woman in this series had had a tumor in her breast forty-nine years.

5 In my opinion it is unsafe to trust to the macroscopic diagnosis of tumors, however skilled one may be, and that a microscopical examination of frozen sections should be made, at the time of operation, of all neoplasms of the breast of which there is any doubt as to their innocency or malignancy.

6 Should the breast of a child approaching puberty be amputated for a

uniform enlargement of that organ or should we delay operation until it is evident that the enlargement is or is not due to physiological conditions?

7 The question of the proper treatment of primary or secondary tumors of the sternum is open to debate. Should extirpation be undertaken or should they be treated with radium or X-rays?

Quénu and Longuet⁷ say in regard to secondary tumors of the sternum "These interest the surgeon but little, it is evident that he ought not to touch a lympho-sarcoma of the mediastinum involving the sternum, and the same is true of cancers of the breast involving the sternum. Nevertheless, one may be induced, by necessity or by foresight, to attack the sternum when in the course of an operation for cancer of the breast or of a recurrence of the cancer, a sternal adenopathy is discovered."

Finney² also says "Whether it is ever justifiable to open the anterior mediastinum or to remove ribs and parietal pleura cannot be settled arbitrarily."

Rodman,⁹ while condemning partial operations for cancer of the breast as worse than useless, advocates very radical operations in some instances. In one case he excised a portion of the sternum and several ribs with a part of the parietal pleura. The woman recovered from the operation and lived nearly three years afterwards. Dr Emmett Rixford,¹⁰ in an excellent paper read before this association in 1905, reports three personal cases in which he excised portions of several ribs and portions of the sternum for recurrent carcinoma, and one case of sarcoma of the clavicle, first rib and sternum, with a large mediastinal tumor, in which he resected the clavicle, a portion of the first rib and a part of the upper end of the sternum. In one of these cases three separate resections of the chest were done. All recovered from the operation and life was materially prolonged in most cases.

Herman Mynter¹¹ reports an excision of the sternum for melanoma of that bone. A girl, aged twenty, had a tumor, the size of one-half an orange, extending from the second to below the fifth rib. It was of eleven months' duration and there were metastases in both axillæ and in both supraclavicular fossæ. The tumor was immovable, with an indistinct sense of fluctuation. The skin was normal in color and not adherent. November 14, 1890, under ether anæsthesia, a "U"-shaped incision was made, convex downwards, the tumor was exposed and scraped out and the bone cut away with bone pliers. The pericardium was exposed for six square inches. The highest temperature was 101 and the wound had healed in ten days.

This was neither a secondary tumor of the sternum nor connected with the mammary glands in any manner, but it was apparently a very malignant growth of the sternum, which was successfully removed, though why it was thought wise to do an operation of such magnitude and gravity on a woman who had extensive glandular metastases in both axillæ and in both supraclavicular fossæ I am at a loss to understand.

8 Equally as serious, and even more frequent, is the extension of cancer from the breast to the ribs. What should be done in such cases? A. P. C. Ashhurst¹² says "Even fixation to the chest wall does not necessarily contra-

indicate excision, the portion of ribs invaded may be removed" The only case in which I have removed ribs for recurrent carcinoma terminated disastrously, but I find quite a number of operations, reported by Fellows of this association, that have been at least measurably successful Thus Rixford, in the article previously mentioned, credits Stillman with the removal of 5 cm of the fourth and fifth ribs for recurrent carcinoma, with a rapid and uneventful recovery, the patient being in perfect health two years subsequently Similar operations have been reported by Dr Elsworth Eliot,¹³ Willy Meyer and Lucius W Hotchiss with encouraging results I think, therefore, that, while in most cases of direct or secondary involvement of the ribs no operation should be undertaken, in some cases it is justifiable and proper to resect the ribs and the underlying pleura

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DIAPHRAGMATIC HERNIA, THE THORACIC APPROACH*

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THE essential purpose of this communication is to call attention to a type of diaphragmatic hernia occurring in the pedestrian child by the passage of an automobile wheel over the upper abdomen, and to consider the methods of cure by operation

A review of the literature on hernia of the diaphragm shows a substantial and progressive increase in the number of cases discovered and cured. It is evident that internists and roentgenologists in particular are on the alert for it. The unexpected is less frequently met at operation and there is abundant evidence to indicate that the mortality figures have been reduced strikingly within a decade.

Scudder¹ found fifty-three operated cases recorded up to 1911. Frank² carefully reviewed the literature in 1919 and could add only forty-one additional cases over a period of about seven years. From 1918 to 1920 inclusive, ninety-six cases have been reported. It is probable that in my search of the literature there has been some overlapping of the series recorded by Frank. Nevertheless, the rapid increase in the number of operations for this deformity is very manifest. Of the ninety-six cases collected forty-three were the results of battle casualties. There can be no doubt that the number of cases treated and not reported is considerable. The number of cases observed among children is singularly small, five in all. Three were of congenital origin and two reported in this article were caused by external violence.

In diaphragmatic hernia intestinal obstruction is the outstanding factor of risk to life. In Scudder's series the surgical mortality was 75 per cent, essentially because of intervention during strangulation of the transposed viscera. Unlike this accident in other types of hernia the process is concealed and the symptoms and physical signs somewhat strange. Hence, delay is the rule and the mortality exceedingly high. The operative mortality in any series depends upon the number of cases encountered during acute intestinal obstruction. Warren³ reported eight cases treated surgically during ten years at the London Hospital. Only one lived. Seven were operated upon in the presence of acute obstruction.

From current reports and observation it appears that most patients, even children, withstand surgical intervention for repair of the diaphragm remarkably well. The general mortality after operation in the non-strangulated type of diaphragmatic hernia averages below 10 per cent. It should be less than 5 per cent when experience is enlarged and the methods of intervention best suited to each case are more clearly defined.

* Read before the American Surgical Association, June 16, 1921

Innervation of the Diaphragm—The primitive mammalian diaphragm is derived from the muscular myotomes which invade the septum transversum. It becomes a muscular partition with an important innervation. In its descent from its position under the fourth and fifth cervical segments the muscle buds carry their nerve, the phrenic, with them. The entire nerve supply of this musculo-fibrous septum has been a subject of absorbing interest to anatomists and physiologists for more than a century. More recently the attention of surgeons has become centred upon a consideration of this phase of the subject because of the congenital defects and injuries of the diaphragm which require operative measures for repair.

The left phrenic nerve, that in which we are particularly interested because hernia is at least eight times more common on the left side, pursues a general anterolateral course and pierces the diaphragm at the junction between the musculature and the central tendon (Fig 1). Under cover of the peritoneum, it splits into an anterior, a lateral and a posterior branch. The anterior supplies the muscle of the left sternal portion and the anterolateral part of the left costal portion. The lateral branch supplies the corresponding part of the left costal section. The posterior branch is distributed to the left lumbar region of the muscle.

In its descent to its permanent level according to Keith,⁴ the diaphragm receives muscle tissue from the transversalis and the rectus sheaths, taking with it an innervation from the thoracic segment of the spinal cord. This innervation of the human diaphragm from the lower intercostal nerves was discovered almost a century ago by several of those accurate observers, the dissecting anatomists. Meckel⁵ described it in 1817. Joseph Swan⁶ gave a very explicit account of this innervation in 1830. He described filaments to the diaphragm from the sixth, eighth, ninth, eleventh and twelfth intercostal nerves.

The careful histological studies of Pansini,⁷ who was the first observer to reinforce the dissection method by histological examination, and of Cavalié, from a dissection of twenty human diaphragms,⁸ confirmed the work of the early observers and proved beyond doubt the existence of an intercostal innervation to the diaphragm. Keith⁹ has shown that in an African toad, the *Xenopus*, the two nerves which represent the phrenic nerves of mammals come off from the second and third spinal nerves, these two nerve branches pass respectively to the ventral part of the amphibian diaphragm and to its dorsal portion. In all birds, except the ostrich, the innervation of the diaphragm is from the intercostals. The ostrich is the only bird which has retained part of its phrenic innervation. Thus, in respect of the nerve supply of the diaphragm, mammals have retained the cervical innervation of their amphibian ancestors. Except its rim, which is supplied by filaments from the seven lower intercostal nerves, Kidd¹⁰ believes that the entire diaphragm derives its pain-conducting nerves from the phrenics. He is of the opinion also that the thoracic innervation is both sensory and motor and comes into action during deep and forced inspiration.

Operations for hernia of the diaphragm have been carried out with little consideration of the permanent, partial functional derangement of the affected half of this septum from rupture, especially that form which results in lacerations of considerable degree. In rare cases where the nature and extent of the defect or laceration is such as to involve one or more of the large branches of the phrenic nerve, it is inevitable that the functional capacity of the affected side of the diaphragm rarely, if ever, returns to normal. In the case to be recorded the diaphragm is shown to have a higher position than normal months after operation. This would indicate defective innervation and a high diaphragm comparable to a moderate degree of eventration.

That part of the diaphragm which is essentially muscular forms its rim. The central portion is fibrous. Under these circumstances, and from a surgical viewpoint, the complete innervation of the diaphragm becomes an important consideration. Admitting that the main nerve supply is from the phrenic, the preservation of an associated innervation such as it derives from the intercostal nerves is a factor to be considered in the transthoracic operation.

Methods of Operation—Both the clinical and structural picture of diaphragmatic hernia varies widely and the method of operation best suited for its repair necessarily remains a problem to be decided upon the evidence in each case.

There are two methods for approaching the diaphragm, the abdominal and the thoracic. Most of the operations reported by American and British surgeons show a decided preference for the abdominal approach while the French favor the thoracic operation. The thoracic cavity is entered so seldom in comparison with the abdomen that, when a choice of approach is to be made, it naturally requires strong inducements to divert the average surgeon from the transperitoneal approach. Then again, so dissimilar are the cases of diaphragmatic hernia in certain particulars that no one plan of approach is best suited to overcome all barriers. Consequently another method which combines the thoracic and abdominal approach has been practiced by Auvray¹¹ and other French surgeons. It consists of a resection of the ninth rib from behind forward to its anterior end, and the incision carried down to the umbilicus. The cartilaginous margin is cut through and the diaphragm incised to the hernial opening. The entire opening in the diaphragm is then sewed up and the wound closed. Auvray terms this procedure a thoracoplaparo-chondro-phrenotomy.

Invasion of one side of the thorax in liberal fashion has become a more common operation since the war, and it is fair to assume that the tendency toward hesitation at the thought of thoracotomy will disappear as operations on the thorax increase.

In a monogram on surgery of the chest from battle wounds, Sir Berkeley Moynihan¹² makes the following comment: "The subject of thoracic surgery is one which before the war had been made difficult by the cumbersome

methods employed. The fear of pneumothorax was present in the minds of most surgeons and was a powerful deterrent." However, Bazy, of Paris, had spoken of the safety of open operations on the chest for years before the war. Cranwell¹³ was among the first to suture the diaphragm successfully by a transthoracic approach. We have evidence that American surgeons were of the same opinion. Binnie,¹⁴ in the second edition of his volume on Surgery, advocated the transthoracic operation in 1906. Carson¹⁵ adopted this method of approach in 1912. Two cases of the delayed incarcerated type were operated upon by Stuart McGuire, of Richmond, Va., in 1912.¹⁶ In a personal communication from Doctor McGuire I have learned of a third case which he has cured by the transthoracic operation.

In order to accomplish the desired end, Frank¹⁷ found it necessary to abandon the attempt by laparotomy and at a second operation successfully closed the aperture in the diaphragm through an opening in the chest wall. Greig, of Edinburgh,¹⁸ has recorded an unsuccessful attempt by the abdominal approach to withdraw the herniated stomach from the thorax on account of adhesions. Downes operated upon a child of seven years by abdominal section. In addition to pyloric stenosis he found the congenital type of hernia. He met with such difficulties that he deemed it unwise to attempt reduction and suture of the diaphragm. Gastroenterostomy was done and a good functional result accomplished. Major C. D. Granger, of the British Army,¹⁹ met with extreme difficulty in suturing the aperture in the diaphragm through an abdominal incision. He was unable to complete the operation satisfactorily after two hours' work on account of the collapsed condition of the patient. A case has been reported by W. J. S. Bythell²⁰ in which an unsuccessful attempt was made by Mr. Howson Ray to deal with the herniated stomach through an abdominal incision in a child of nine years. At the first operation he merely sutured the stomach to the abdominal wall. Apparently an attempt to close the gap in the diaphragm appeared to be inadvisable. The hernia soon recurred, and after a few weeks a gastrostomy was performed. Andrews²¹ describes an operation during which he found dense adhesions of the omentum within the thorax. He was unable to separate these from below without considerable risk, so he sectioned the omentum and left it in the pleural cavity. Wiart,²² in working from below, found it impossible to close the opening in the diaphragm completely. Weiss and Dujarier²³ found the abdominal approach so difficult that they were at the point of abandoning the operation.

A case reported by Jopson,²⁴ seen in consultation at Base Hospital, No. 18, A. E. F., was dealt with successfully by thoracotomy after a second attempt by laparotomy had failed to relieve attacks of intestinal obstruction.

Thus in scanning the literature one finds ample evidence to show that in a good proportion of cases the abdominal approach is by no means ideal and probably is beset with more difficulties and dangers than the transthoracic way.

Among the advantages which may be claimed for the thoracic operation are the following: (1) Thoracotomy affords a more direct approach. (2)

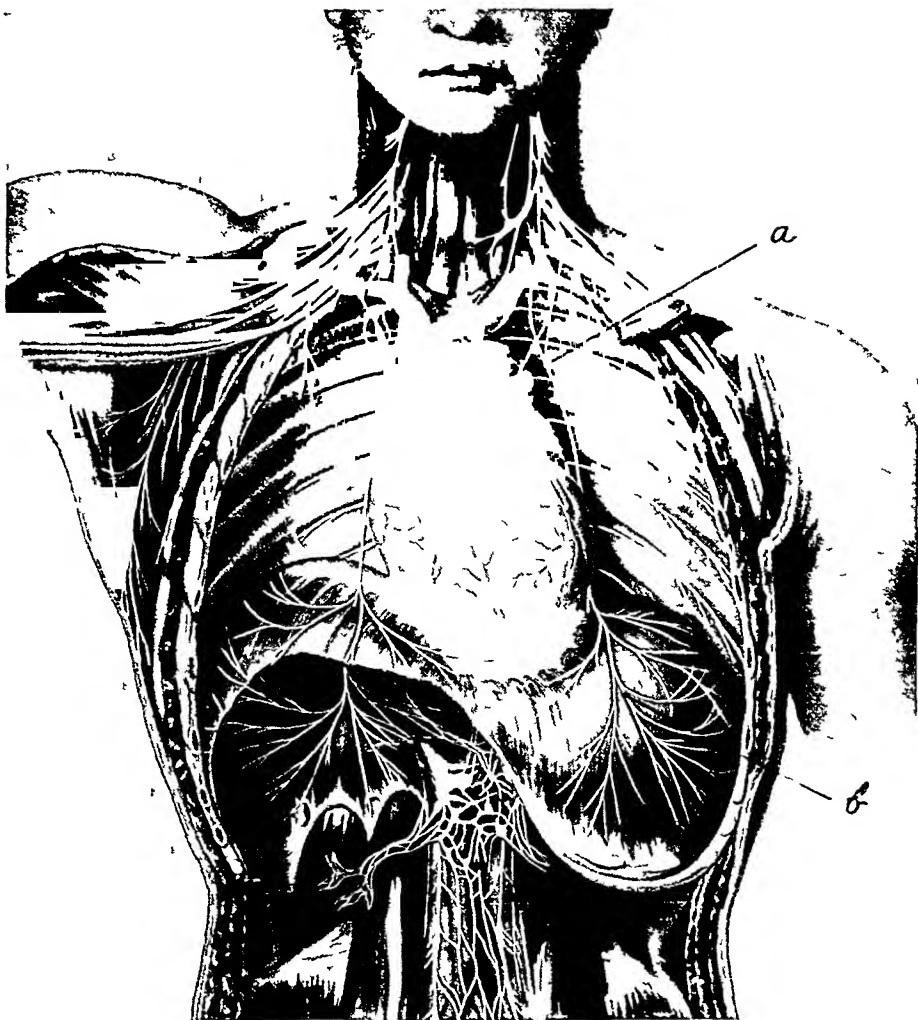


FIG 1 --Showing (a) the course of the phrenic nerve and (b) its distribution where great damage may result to the innervation of the diaphragm from rupture.



FIG 2 —Rontgenogram showing herniated abdominal viscera in the left pleural cavity

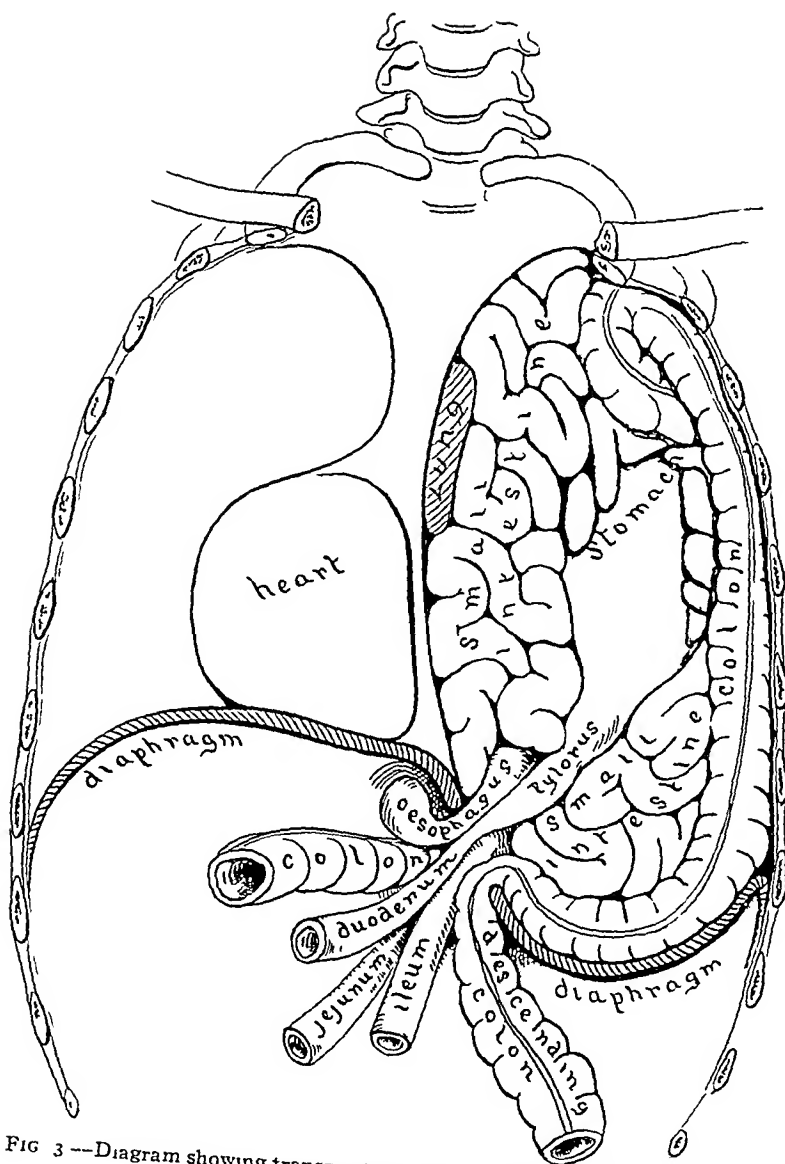


FIG 3 ---Diagram showing transposition of abdominal organs into left pleural cavity in Case I

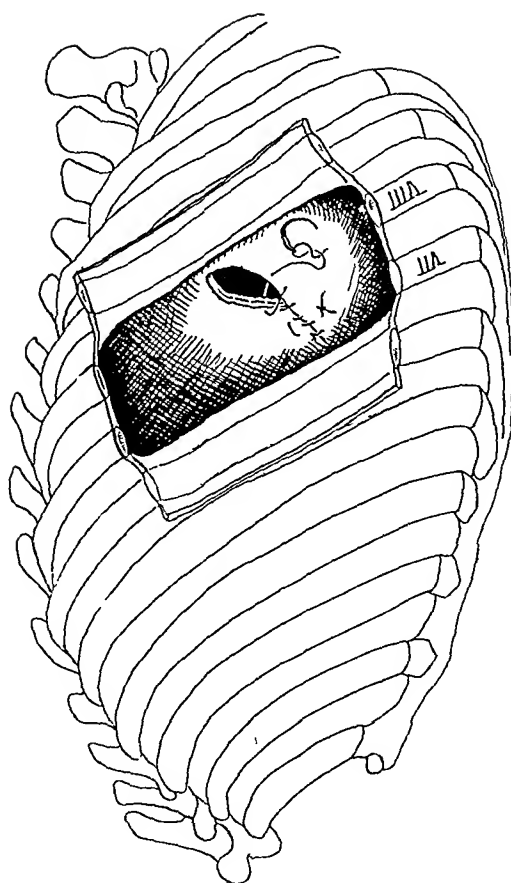


FIG 4.—Trap door opening in thoracic wall and suture of aperture in the diaphragm

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Pneumothorax and collapse of the lung are not to be feared. They exist already, as inevitable consequence of a hole in the diaphragm. (3) The open thorax allows the separation of adhesions under the eye of the operator. (4) Once the herniated viscera are replaced within the abdomen, they are out of the way, warm and well protected. (5) There is less shock from the thoracic operation. (6) If a hernia sac exists it can be disposed of in the most advantageous manner. (7) Operating on the convexity is more natural and more simple than suturing within the concavity of the diaphragmatic dome.

Based on these premises the transthoracic approach to the diaphragm appears to be the more logical and sound. However, a single experience or observation is sometimes all that is necessary to demonstrate how easily one may be led to miscalculate on the virtues of a chosen method. In order to make this evident by demonstration I shall record two cases of diaphragmatic hernia in young children. Each was produced in the same manner, *i e*, by the passage of an automobile wheel over the upper abdomen. The two cases were comparable in their important features with a single but important exception. One was operated upon by the transthoracic approach, the other by laparotomy.

CASE I—L S, a boy, aged five years, was run over by an automobile on May 11, 1920. He was taken to a hospital, where examination showed that he was severely injured internally, but the exact nature of the trauma could not be determined. In December, 1920, he began to have attacks of a peculiar nature resembling intestinal obstruction. These increased in frequency and severity. On January 4, 1921, after passing through the hands of many doctors, he was examined by Dr Henry I Bowditch and Dr John T Bottomley, of Boston, who made the diagnosis of diaphragmatic hernia. Later this was confirmed by roentgenologic examination by Dr Ariel George.

The boy was admitted to our clinic for operation on February 23, 1921. With all the evidence required in our possession, it was obvious that surgical intervention was urgent. After due consideration of the abdominal and thoracic methods of approach, it was decided to attempt a reduction of the displaced organs and a repair of the opening in the diaphragm by the thoracic route.

Anæsthesia—Although the child showed no evidence of organic disease, he was anæmic and obviously asthenic. This lowered state of his endurance and the stress of the proposed operation gave accent to the importance of the choice of anæsthetic and the manner of its administration.

The anæsthetist, Miss A M Hunt, employed the method advocated by Sir Berkeley Moynihan, omitting his preliminary hypodermic injection of morphia, scopolamin and atropin. Nitrous oxide gas was employed for induction, shifting promptly to ether and oxygen. From the beginning the anæsthesia was pushed to a considerable depth allowing complete muscular relaxation. This was accomplished without cyanosis. From the inhalation of an excess of oxygen, a bright red color of the child was maintained. The closed inhaler of Connell was used, thus reducing the required amount of ether for the operation to about an ounce. The range of respiration was kept shallow. This partial control of motion in the thorax greatly facilitated reduction and suture.

Operation—A lapel incision (Cranwell) was made through the soft tissues over the seventh and eighth ribs. The pleural cavity was opened by an inter-

costal incision the entire length of the shaft of the rib. The seventh and eighth ribs were each severed in two places, first at the angle and then at the sternal extremity. Turning the seventh rib upward and the eighth downward gave a double trap-door opening into the left thoracic cage. As soon as the pleura was incised, distended loops of small bowel escaped and could be reduced only after the intrathoracic pressure was minimized by spreading the wound wide open with rib retractors. The chest cavity was filled with stomach, small and large bowel. The left lung was collapsed against the spine and resembled the spleen in appearance. The diaphragm was prolapsed. Near its central attachments was an opening occupied by the herniated abdominal viscera. There was a close grip by the aperture upon its contents, and engorgement of the circulation indicated that strangulation was impending as a result of the stricture. There were no adhesions and no sac. Efforts to replace the intestine within the abdomen manually were encompassed with difficulties. As fast as the bowel was passed downward through the opening it was sucked up again. Repeated efforts resulted in failure and no progress whatever was made until the diaphragm was elevated to a much higher plane by placing two fingers under the outer margin of the hernial ring. Thus a partial vacuum was created within the abdominal cavity and the small gut, the transverse colon, and finally the stomach were pushed through into the abdomen by the use of long, curved, blunt forceps. Once restored, it was not difficult to keep the abdominal viscera under the diaphragm by the use of a gauze pad. The remainder of the operation was comparatively simple. Exposure of the aperture in the diaphragm was ideal. The gap began a few centimetres posteriorly and external to the oesophageal opening and extended in an oblique direction forward and outward. A moment's inspection showed that it did not involve any of the normal openings. It was somewhat elliptical with the long diameter about four inches. The edges of the opening were rounded and thickened. Closure was accomplished by a continuous suture of No. 2 iodized catgut reinforced by several interrupted deep sutures of the same material. The thoracotomy wound was closed tight with catgut and several mass sutures of silkworm gut. The little patient stood the operation remarkably well and made an uneventful recovery, leaving the hospital on the fourteenth day.

CASE II—Was seen at the Rhode Island Hospital on the service of Dr. J. C. O'Connell, May 21, 1921. The patient was a boy, aged three and a half years. He was run over by an automobile April 28, 1921. Admitted to the Rhode Island Hospital in a state of shock. The chest signs were very unusual. Hernia of the diaphragm was suspected by Dr. R. G. Bugbee. A barium enema was administered and a roentgenogram showed the colon in the left thoracic cavity. There was a small hernia of the abdominal wall under the left costal angle produced by the weight of the wheel in passing over the child's body. Doctor O'Connell decided to approach the diaphragm by laparotomy and made his incision over the site of the hernia. Upon investigation he found that the stomach, jejunum, transverse colon and left lobe of the liver had passed through a large opening in the middle of the diaphragm. Another laceration extended transversely across the anterior third, involving the right wing of the diaphragm and opening the pericardium for a distance of about 5 cm. The heart could be seen plainly and at times dipped through the opening into the abdominal cavity. Both lacerations were closed by interrupted catgut sutures. Doctor O'Connell reports that the boy has made a good recovery and the operation a success, as shown in subsequent roentgenograms.

The surprise in this case was the laceration extending across the diaphragm to the right side and laying open the pericardium. It might not have been overlooked during an approach from above, but there is a fair if not a

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big liability, that it would have passed unseen. This case accentuates the importance when operating through the chest wall of palpating the underside of the diaphragm as far as the hand can reach.

Aside from the advisability of using the abdominal approach whenever it is thought necessary to operate on a hollow viscus, it must be conceded that another strong argument, if not an incontestible one in favor of laparotomy, is the opportunity thus afforded for examination of the entire diaphragm.

Operation for the cure or relief of diaphragmatic hernia during childhood is rarely found in literature. Many text-books on Pediatrics fail to mention the subject. Holt describes a case of diaphragmatic hernia observed in a child sixteen months old who died of pneumonia at three and a half years. In concluding his notes the author states that the condition is not amenable to treatment. The case recorded by Downes and that reported by Bythell have been noted already. They were of congenital origin.

That the traumatic cases should be operated upon as soon as conditions warrant there can be no question. One should be able to make the diagnosis promptly if the physical signs are carefully noted with diaphragmatic hernia taken into consideration. Nevertheless, immediate operation is inadvisable because a state of shock exists as a result of lung collapse and pneumothorax, not hemorrhage. The amount of bleeding from the torn edges of the diaphragm is probably slight.

A case reported by Balfour, although an adult, was of the non-strangulated type of hernia of the diaphragm in which the diagnosis was made prior to operation. In many respects the conditions were analogous to those found in the cases recorded in this paper. Balfour's difficulties were encountered essentially after reduction of the herniated structures. He found no difficulty in withdrawing the abdominal viscera from their position in the thoracic cage, but it was a struggle to prevent them from being sucked back. This was accomplished by introducing large retaining packs of gauze held in a position for retention by outspread hands. So it was in Case II, O'Connell was continually annoyed by the escape of the abdominal viscera from behind the retaining packs. Our embarrassments occurred earlier and consisted of an almost insuperable task met in passing the herniated stomach and intestine through the aperture in the diaphragm into the abdominal cavity until a vacuum was created within the abdomen as already described. Catgut was used in both of these cases for closure of the apertures. In one the continuous suture was used, and in the other the interrupted stitch was employed. With the interrupted suture small open gaps remain, while the continuous stitch makes a tight line. With several interrupted supporting sutures this airtight closure is to be preferred.

CONCLUSIONS

1 Early recognition of diaphragmatic hernia has reduced the surgical mortality from 75 per cent to 10 per cent.

2 An important type resulting from external violence is now recognized among pedestrian children

3 Many congenital hernias of the diaphragm do not require operation

4 The thoracic operation affords a direct approach, also many advantages in dealing with intrathoracic adhesions and actual repair of the aperture in the diaphragm

5 The abdominal approach allows inspection and repair of a gap in either side of the diaphragm Its simplicity is enhanced by a low diaphragm and the absence of adhesions within the thorax

6 The combined operation is a third choice, preferable only to separate incisions, thoracic and abdominal

7 The choice of operation must remain the individual surgeon's problem, to be decided upon a consideration of all the factors in each case

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PERNICIOUS ANÆMIA WITH SPECIAL REFERENCE TO THE SPLEEN AND THE LARGE INTESTINE*

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PERNICIOUS anæmia is characterized by progressive degeneration of the red blood, permanent change in the method of the production of blood, marked changes in the spinal cord, achlorhydria, and glossitis. The relation of the cord changes, achlorhydria, and glossitis to the anæmia has not been determined. The view held formerly, that the conditions were dependent on the anæmia, is scarcely borne out by the fact that the symptoms are found in the earlier stages of the disease, neurologic examination showing that the cord changes may be as characteristic at any stage of the disease as the blood picture. The etiology of pernicious anæmia is unknown, the early symptoms are indefinite, and by the time a diagnosis can be established the condition is incurable.

It has been asserted that certain cells found in the blood of patients with pernicious anæmia are characteristic, but most observers agree that the pathologic change is in the blood as a whole, rather than in the development of specific types of blood-cells. While it is known that the actual perversion of the red-cell formation lies in the bone marrow, few believe that the cause originates therein. One might say that the bone marrow of a patient who has died from pernicious anæmia furnishes only presumptive evidence of the disease. The pathologist would indeed be enthusiastic who asserted that in anæmia other than of the aplastic type he could make a diagnosis of pernicious anæmia from the bone marrow examination alone. The diagnosis of pernicious anæmia is by no means certain in the early stages. Most diagnosticians have had under their care patients believed to have pernicious anæmia in the early stages who recovered with or without treatment. All have seen patients in whom the disease was so insidious in its manifestations that it had reached the incurable stage before its existence was suspected. Giffin, Woltman, and Szlapka now have under observation a number of cases in which there are achlorhydria and some evidences of changes in the cord and tongue, but as yet without anæmia. It will be interesting to learn in what percentage, if any, of these cases pernicious anæmia develops.

THE RELATION OF THE SPLEEN TO PERNICIOUS ANÆMIA

The relation of the spleen to the formation of the blood led the earliest observers of pernicious anæmia to suspect that the spleen was associated with the disease. It remained for Eppinger to suggest that the removal of the spleen might cure, and early reports give testimony of temporary relief after splenectomy sufficient to justify a fair trial of the operation. Considering the confusion which so often attends the early diagnosis, it seems probable

* Presented before the American Surgical Association, June 14, 1921

that obscure cases of hæmolytic icterus and splenic anæmia may have been accidentally included in the pernicious anæmia group, especially since the pathologic changes in the spleen in pernicious anæmia are not characteristic of the disease. Removal of the spleen in such cases has possibly given the impression that splenectomy may cure pernicious anæmia. It has been a tradition of the medical profession that recovery of a patient in the face of a diagnosis of pernicious anæmia proves the diagnosis wrong, and this conviction is still so strong as to prevent our readily accepting reports of cures. Even a superficial examination of the literature on pernicious anæmia brings out in striking manner the fact that any form of treatment for pernicious anæmia may be beneficial, or at least may appear to be beneficial. Patients with pernicious anæmia have their ups and downs, and in an occasional case in which the diagnosis seemed to have been established by physicians of repute, there has been recovery which has lasted for years. Eppinger's work at least demonstrated that the removal of the spleen initiated striking temporary improvement. In the cases observed in the Clinic there was marked gain in weight, and improvement in hæmoglobin on an average of from thirty-six to seventy-two per cent, and the red-cell count increased on the average from less than 2,000,000 to more than 4,000,000.

Previous to November 1, 1917, fifty splenectomies had been performed in the Clinic for definitely established pernicious anæmia. The operation was then discontinued almost entirely for three and one-half years. Since there was not sufficient evidence that splenectomy would cure these patients, and since at that time the procedure was not known to give a degree of palliation sufficiently greater than that following blood transfusion, it seemed wise to await the verdict of time. Giffin and Szlapka have recently investigated the condition of these fifty splenectomized patients, and the pessimism which existed in the Clinic has been partly dispelled, at least. It was found that twenty-one and three-tenths per cent of the patients with pernicious anæmia survived the operation three years or more, living two and one-half times as long as the average in a similar group of nonsplenectomized patients at the same stage of the disease, and that ten and six-tenths per cent are alive after more than five years. This clearly indicates in at least one-third of the cases that the average life of patients with pernicious anæmia is greatly prolonged, and in about ten per cent the prolongation is sufficient to lead to the hope that cures may result in some cases. We must take into consideration too the fact that no allowance was made for the normal mortality for the age period, all the patients who died were considered to have died from pernicious anæmia. In the literature I have not found a comparable group of non-splenectomized pernicious anæmia patients who have done as well. The results in these fifty patients have been much better than we expected they would be when we abandoned the operation, they suggest that in certain early cases, of a type as yet not fully recognized, splenectomy offers a possibility of cure. Not only is this true, but also in the average cases the palliation following splenectomy is much greater than we have been able to obtain

by blood transfusion Transfusion gives temporary benefit It seems to furnish red cells which may live and function for one or two months or more, but there is not as yet evidence that the actual prolongation of life by that means is considerable The blood picture improves after splenectomy, but the achlorhydria continues, and careful examination of the nervous system does not show changes for the better in the physical condition of the nerve structure, although the patients are much better in this respect clinically A perhaps comparable showing was made by Stokes, in the Clinic, who found that careful treatment in syphilis of the nervous system made eighty-six per cent of the patients self supporting, although the neurologists on examination were not able to find that there had been any marked change in the physical condition of the nervous system Perhaps a lesion in the spinal cord gives physically the same signs whether the process is active or whether it is the scar of a former lesion Clinically an ulcerating syphilitic lesion of the skin is more troublesome than the scar of a healed lesion

The course of pernicious anæmia following splenectomy, generally speaking, is ameliorated, the relapses are less severe and the cord changes less rapid than after transfusion or any other form of treatment with which we are acquainted One of the functions of the spleen is to destroy deteriorated red cells Apparently in pernicious anæmia the red cells are born feeble and the spleen sacrifices red cells which, although imperfect, are the best the patient can produce and are capable of function Removal of the spleen stops this destruction, but does not greatly affect the disease otherwise The cases which seem to be most favorable are those in which hæmolysis is most active, and those least characteristic of the disease It also seems certain that early cases give a better prospect of benefit than late cases When the disease has advanced to the point at which the bone marrow has been injured beyond the power of recuperation, the most to be expected is a temporary abatement of the symptoms

Pathologic examination of the spleens we have removed has been rather disappointing If we might assert that in the cases of pernicious anæmia in which splenectomy was performed characteristic pathologic changes are found in the spleen, or that greater clinical improvement followed splenectomy in pernicious anæmia when the spleen was greatly enlarged, we could establish a definite relationship between the enlarged spleen and the disease, but the size of the spleen did not seem to bear any definite relationship to the severity of the disease Necropsies after death from pernicious anæmia have often shown the spleen to be small, but during the life of the patient the spleen is usually enlarged The average weight of the spleens removed in our cases was 400 gm (195 gm normal, Sappey) exclusive of two large spleens, one of which weighed 1600 gm, and the other 2220 gm It seems probable, therefore, that during the course of pernicious anæmia the spleen is enlarged, but that this enlargement is reduced to a certain extent in the terminal stages of the disease The spleens removed during the earlier stages of the disease, therefore, would show an average greater weight and size than would be found at ne-

cropsy In only two of our cases (both terminal) was the spleen below normal size In pernicious anæmia of the aplastic type the changes in the bone marrow are most marked and the spleen small Whether this has any significance I do not know

The question is not yet answered whether pernicious anæmia is a definite entity or whether it is a terminal change of several conditions, and recognizable as pernicious anæmia only when the patient has reached the state which we know will eventuate in death If we assume that the removal of the spleen has a beneficial effect, as appears from the evidence at hand, are we to assume also that the spleen is the cause of the changes in the bone marrow? A study of the literature and of our cases does not give this impression It would be more reasonable to assume that the same agents which destroy the bone marrow injure the spinal cord, produce the achlorhydria and the glossitis, affect the spleen, and that by removal of the spleen a vicious circle is interrupted

The operation of splenectomy for pernicious anæmia is simple Among the first nineteen patients we had three deaths The patients were operated on during crises as a last resort in very advanced cases The best plan is to transfuse once or twice in order to get the patient on the up grade before operating and not to operate during a crisis We have had no operative death in the last forty cases

THE POSSIBLE RELATION OF THE LARGE INTESTINE TO PERNICIOUS ANÆMIA

Many observers have expressed the belief that toxic materials from the gastro-intestinal canal are the cause of pernicious anæmia, and if this is true the probable location of this absorption would be in the proximal half of the large intestine In a former communication* I discussed the physiology and pathology of the right half of the large intestine, my interest being excited primarily by the frequency of surgical tuberculosis and carcinoma of the large intestine, and still further by the work of Lane on intestinal stasis, which, like Banquo's ghost, will not down There is a mystery concerning this portion of the human anatomy which conceals some queer metabolic disturbances, possibly, as I pointed out before, the result of throwing protein end products, which quickly undergo putrefactive changes, into an organ like the proximal absorbing half of the colon which primarily has an herbivorous function Carcinoma or tuberculosis of the proximal half of the large intestine produces an anæmia, unexplained by hemorrhage, much more severe than the anæmia of carcinoma or tuberculosis of any other part of the body Carcinoma of the fundus of the stomach perhaps is the only condition which produces an unexplained anæmia which is in any way comparable Tumors in the right half of the colon which are curable by operation may cause a reduction of the hæmoglobin to below twenty-five per cent, edema of the lower extremities and a general physical condition which would apparently place the patient beyond surgical interference Experience with a large number of re-

* Mayo, W J Resection of the first portion of the large intestine and the resulting effect on its function Jour Am Med Assn, 1914, LIII, 446-449

sections for the relief of such patients in wretched general condition has shown a comparatively low mortality and a high percentage of permanent cures

The flaw in Lane's assumption that the colon is the source of toxins is the failure to find evidence of disease on removal of the colon, beyond adhesions, dilatation and atony. Yet the same is true of exophthalmic goiter, the thyroid tissue of the hyperthyroidism is, strictly speaking, not so much abnormal as hypertrophied and superactive

Some very interesting observations on *Balantidium coli* as the cause of blood and cord changes of the pernicious anæmia type have been made by Logan, of the Clinic, and, in a way, the cases studied support the hypothesis of the intestinal origin of pernicious anæmia. The *Balantidium coli* is a flagellate parasite which rarely inhabits the intestinal tract of man, but is common in the pig. In man it is found in the intestinal wall, the blood-vessels, and other organs, it has the power of encysting and produces ulcers. The symptoms and findings of pernicious anæmia or of an anæmia which cannot be distinguished from it accompany the chronic type of the infection. Eosinophilia is not present in the chronic cases. Glaesseeur has found a hæmolytic agent in *Balantidium coli*. Since this parasite penetrates the intestinal wall and its blood-vessels and other organs of the body, and encysts, it is impossible to be sure that the organism is not harbored in the tissues of the body simply because it has been eradicated so that it is no longer found in the stools. Thus, if the pernicious anæmia syndrome persists, it cannot be determined whether the *Balantidium coli* hæmolysin is still active, or whether once the complex is started it becomes an entity. In any event the pernicious anæmia of *Balantidium coli* progresses to a fatal issue. The number of observed cases is small and the pernicious anæmia might have been a coincidence. Honest card players have been known to hold four aces.

I fully realize that there is little evidence to show that the etiologic agents of pernicious anæmia arise in the large intestines. Pernicious anæmia annually destroys more than 6000 lives in the United States. Even though the disease is common, we have learned comparatively little concerning it during the past generation. It behooves us to keep an open mind, to study carefully the blood conditions of all patients who have disease of the large intestine, to try to ascertain whether anæmia, achlorhydria, glossitis, or some other abnormal condition exists, and especially to study carefully all cases in relation to cause and effect in which the large intestine is removed or in which splenectomy is performed.

SOME SECONDARY COMPLICATIONS OF POSTERIOR GASTRO-ENTEROSTOMY*

By EDGAR A. VANDER VEER, M.D.
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ATTENDING SURGEON TO THE ALBANY HOSPITAL

SINCE during the last few years the end results of surgery are being studied more and more and the value of an operation is based upon the eventual benefit which the patient has derived, I believe that the following two cases of posterior gastro-enterostomy, with their secondary complications and their end results, are of sufficient interest to bear reporting

CASE I—J. E. T., Raquette Lake, N. Y., age forty-nine, United States guide and gardener, entered the Albany Hospital August 5, 1910. Discharged September 2, 1910. Recovered.

Patient states that about seven years ago he had attacks of stomach trouble and was treated by his physician for indigestion. He has had a number of these attacks ever since, averaging about four each year. On July 6, 1910, while at work, he was taken with dull pain in epigastrium extending down to umbilicus, at times the pain would radiate downwards towards pubes and also around to back on both sides, but being more persistent on right side. He stopped work on July 8th, and went to bed July 13th, on the advice of his physician. Has been out of bed since July 18th. On July 6th he had an attack of nausea and vomiting. On July 27th he had another attack of nausea and vomiting. He says that his appetite is good but a little food seems to satisfy him. He has never seen any blood in vomitus nor does he recognize any particles of food of previous meals. There is no certain time after meals for vomiting to recur, says it may vary from four to six hours or more. Patient can eat fruits, tomatoes, but meats seem to distress him. At times he has eructations of acidulous fluid into mouth. Tongue is slightly eroded in middle but red on edges and tip.

Physical examination revealed a small indurated mass in the epigastric region, rather to the right of the median line. No glands palpable in the body. Examination of stomach contents disclosed a small amount of blood, undigested food and lactic acid bacilli. Examination of urine showed a large number of hyaline and granular casts, about 3 per cent of albumin, no sugar, specific gravity 1016.

It being before the time that the technic of the X-ray examination of the intestinal tract had been developed, no radiographic examination of stomach was made. From the clinical history and the physical findings a diagnosis of pyloric obstruction was made, probably malignant in character.

Operation, August 10, 1910. A tumor size of a horse chestnut, having many characteristics of an inflammatory nature, was found at

* Read before the American Surgical Association, June 16, 1921.

the pyloric end of stomach, causing partial obstruction. No lymph-glands found involved. A posterior gastroenterostomy was made. An uneventful convalescence followed, and the patient left hospital on September 2nd apparently well and eating anything he wished. Pathological report of intestinal mucosa was negative. No evidence of malignancy in fragment submitted. Examination of urine upon discharge from the hospital was practically negative. This man reentered the hospital October 11, 1913, for removal of a prepatella bursa of right knee. He reported that he had no trouble from his stomach whatsoever and could eat any kind of food without distress.

He again entered the hospital October 21, 1914, complaining of pain and distress in his stomach, and frequent urination. Examination of specimen of urine at that time gave results as follows: No sugar, granular and hyaline casts, acid 1018, albumin. Smears—no tubercle bacilli or other organisms seen. Cultures—sterile at the end of forty-eight hours' incubation.

The patient admitted having partaken freely of alcoholic stimulants for the past few months.

Under appropriate treatment stomach and kidney condition cleared up and he left the hospital October 27, 1914, recovered.

He reentered the hospital October 8, 1918, complaining of distress and pain in stomach and diarrhoea. At this time Röntgen diagnosis was: Oesophagus normal. In standing position the stomach empties very rapidly through the gastro-enterostomy opening, but some barium is seen to leave by the pylorus. No incisura, filling clefts or notches seen. Cap seems normal. The stomach does not empty so fast through gastro-enterostomy opening in prone position. There is very slight six-hour retention. Barium has reached the descending colon, but most of it is in the cæcum, a small amount is in the small intestine.

Owing to the clinical and X-ray findings, an exploratory operation advised. Patient returned home and returned at the end of a week, and entered the Homœopathic Hospital, where the abdomen was reopened through the old scar. Examination of the pylorus, the site of the tumor found at the operation August, 1910, revealed a normal pylorus with absolutely no evidence of any tumor or cicatricial tissue. At the site of the gastroenterostomy, however, was found a tumor mass about the size of the one previously found at the pylorus. In addition the lymph-glands along the spine were involved. Clinically, the case presented was one of carcinoma. Owing to the poor condition of the patient no tissue for pathological examination could be removed. The incision closed. The patient is still living, two and a half years afterwards. Why did this man not make a complete cure?

There is much doubt as to the case being malignant, but is it not quite probable that it is one of those cases which we are beginning to recognize as a secondary ulcer occurring at the site of the gastro-enterostomy? Where is the fault in this case along the line of metabolism producing a condition tending to gastric ulcer? This case presents two interesting points. First, the fact that in cases of inflammatory or malignant disease where we can

stop the irritation of the growth, we can either stop the growth and have it disappear entirely as it did in this case, or else we can so diminish its growth as to greatly relieve the patient, as is shown in cases of carcinoma of the rectum relieved by a colostomy and the patient given comfort for months, if not years

The second point is the appearance of the growth, possibly carcinoma, at the site of the anastomosis, showing that the irritation of the gastric juice must have set up a new growth entirely independent of the previous growth at the pylorus. Case is now in the hands of Doctor Worrell, who diagnosed the case as one of chronic interstitial nephritis

CASE II—G Y H, Jr, aged thirty-six, single, farmer by occupation, was brought to hospital on January 11, 1915, in a state of collapse, and with the history that for past two or three years he had had trouble with his stomach. In the beginning there was only pain in the stomach before meals, which pain was relieved by eating. About three hours after eating the pain would return. He would have a lot of gas on stomach. Later pain diminished somewhat and patient would vomit large quantities of food. This vomitus would be of a sour taste, burning when it came up and of a dark brown color. During the night of January 11, 1915, he was seized with severe pain in the epigastric region, and went into a state of collapse. He was operated upon next morning for a perforated gastric ulcer. Closed by use of silk purse-string suture. Drainage with gauze and one rubber tube. Counter-drainage in right iliac fossa. He left the hospital February 4, 1915, apparently well.

He reentered hospital March 25, 1915, complaining of pain in region of old trouble. Since leaving the hospital in February has some pain, but is bothered with distress in stomach and would vomit occasionally, the vomitus being light in color. He entered hospital March 25, 1915, to be relieved of distended stomach. Posterior gastroenterostomy performed March 26, 1915, from which he made a good convalescence and left the hospital April 14, 1915, feeling absolutely well and able to eat anything in reason.

He remained well for two years, when he commenced to complain of his old symptoms, which would yield at times to appropriate treatment. On February 23, 1919, he was seized with an acute pain in the epigastric region and went into a state of collapse, from which he rallied and the pain gradually localized itself in the region of the appendix. He was brought to the hospital, an incision was made over the region of the appendix, which was removed, slightly congested, but the abdomen was found full of gastric contents. An incision was then made through the old gastroenterostomy wound and a perforated ulcer found at the site of the anastomosis on the jejunal side. This perforation was closed by a mattress silk suture. Two rubber drainage tubes inserted in upper and lower edges of wound. He made a slow but uninterrupted convalescence and left the hospital March 6, 1919, in good condition. He has remained well ever since, has had no more distress in stomach, is able to eat anything he wishes, and has gained considerably in weight.

COMPLICATIONS OF POSTERIOR GASTRO-ENTEROSTOMY

The interesting point in this case is the fact of his developing an ulcer at the site of the anastomosis giving very little, if any, symptoms, until its final perforation. Also the fact that he made a good recovery from the perforation even though the diagnosis and operation were delayed for twenty-four hours. I am free to confess that I should have made the diagnosis more promptly, but the fact that he had had very slight previous gastric symptoms and that he had had one perforated gastric ulcer did not seem to make it possible that he should have another. As a matter of fact, the possibility of such a condition being present was not even thought of.

That peptic ulcer occurs at the site of a gastroenterostomy is of course a well-known fact, and numerous cases of that condition are reported in the literature. Various theories are advanced for the same, and the fact that they do occur probably accounts in part for some of the failures to give relief in stomach surgery.

A thorough search of the literature, however, fails to reveal the report of a case of perforation of an ulcer so occurring. Though, of course, there is no reason why a perforation could not occur as well in that situation as in a primary gastric or duodenal ulcer. So far as treatment is concerned, I merely closed the perforation by a purse-string silk suture and drained. He has had no subsequent symptoms.

Contrast these two cases with the history of a third patient, Mr. G., aged sixty-six, upon whom I operated for a stenosis of the pylorus, performing the identical form of operation, who had absolutely no stomach symptoms afterwards, lived for fifteen years and then died of pneumonia.

Why should the two cases in the younger patients develop secondary ulcer and the third case, in a much older man, make practically a perfect recovery?

TYPICAL FIBROMYOMA OF THE ABDOMINAL WALL FOLLOWING HYSTERECTOMY

BY GEORGE EMERSON BREWER, M.D.
OF NEW YORK

THE object of this communication is to report and place on record the history of a patient in which a large, typical, fibromyomatous tumor developed in the abdominal wall, in the scar of a previous laparotomy undertaken for the removal of an uterus, which was the seat of multiple growths of the same character.

In May, 1911, Mrs E, thirty-one years of age, sought my advice in regard to treatment of a large tumor of the lower abdomen, which upon investigation proved to be a uterine fibroid. As the tumor had been growing rapidly and had already given rise to definite pressure symptoms, an operation for its removal was suggested. Accordingly under ether anæsthesia, after the usual preparation, the abdomen was opened in the median line and the uterus, both tubes, and the left ovary were removed. On subsequent examination, the uterus was found to be the seat of several fibromyomata, varying considerably in size, the largest arising from the posterior wall near the fundus, measuring about 50 cm in circumference. The patient made a satisfactory convalescence, the abdominal wound healing by primary union.

She remained well for nine years. In the late autumn of 1920, however, she began to experience a sense of weight and indefinite pain in the lower abdomen and right side. These symptoms were not constant, but would recur after severe or unusual exertion, and in January, 1921, there was added a slight irritability of the bladder which gradually increased, necessitating frequent micturition. There was no noticeable interference with nutrition, no loss of strength, and no anæmia, but the symptoms gave rise to a certain degree of anxiety and apprehension, which finally led her again to seek my advice.

On physical examination, an oblong, oval tumor was found in the lower abdomen, reaching from the pubis upward and somewhat to the right to a point three inches below the umbilicus. The tumor was moderately movable, was not tender, had a smooth uniform surface, and gave to the examining hand the sensation of an ovarian cyst. On bimanual examination these findings were verified, and I was convinced that we had to do with a cyst arising from the remaining right ovary, pressing upon the bladder, and not attached to the cervical stump which was freely movable without transmitting its motion to the tumor. As there was no unfavorable factor revealed by the general physical examination which followed, an operation for the removal of this supposed ovarian cyst was advised. On January, 1921, at the Presbyterian Hospital, under ether anæsthesia, an incision was made through the right rectus muscle. As soon as the fibres of this structure were retracted, there was exposed what was thought to be a greatly thickened and highly vascular peritoneum, numerous large veins passing irregularly across the field in various directions and apparently ceasing abruptly as if they penetrated to some deeper structure. Several unsuccessful attempts were made to incise the peritoneum, but the blade of the scalpel opened no cavity, and seemed only to incise a dense solid mass which bled freely. Believing that these conditions only indicated that the cyst was densely adherent to the thickened parietal peritoneum, I divided the tissues carefully, until I exposed a

* Read before the American Surgical Association, June 15, 1921

FIBROMYOMA OF THE ABDOMINAL WALL

grayish, non-vascular, fibrous membrane, which I thought to be the cyst wall. From this I separated the thickened tissue on either side by blunt dissection, until a sufficient area was exposed to convince me that it was the surface of the tumor. An aspirating needle was then introduced, but without result, other than imparting to the hand the sensation that it passed into a dense fibrous mass.

Still convinced that I was working within the peritoneal cavity, and that I was dealing with a solid tumor arising from some one of the abdominal viscera, I attempted cautiously still further to expose its surface by separating from it its dense fibrous and vascular envelope. Much to my surprise, as I worked outward from the median line, I was able soon to detect with my finger a distinct line of cleavage, and in a few moments was able easily to enucleate the entire tumor from its bed. After its removal I found that at one point a small opening had been made through the posterior wall of the surrounding membrane into the peritoneal cavity. This opening was enlarged sufficiently to admit my hand, when it was found that the inner layer of the peritoneum was perfectly smooth and free from adhesions with any of the abdominal viscera. This conclusively demonstrated that the growth was an extraperitoneal tumor lying between the peritoneum and the rectus muscles, surrounded by a dense, highly vascular capsule made up of thickened and subperitoneal areolar tissue.

On section the tumor presented the gross appearances of a typical fibromyoma, without any suggestion of malignancy. After accurate hæmostasis, the peritoneum was united with catgut, the muscular and aponeurotic structures with chromic gut, and the skin incision closed by silkworm-gut and silk sutures. Her recovery was without incident, and except for the usual post-operative sensations, she has enjoyed the best of health.

On examination the tumor was found to have the following measurements: 16 cm. in length, 13 cm. in breadth, and 9 cm. in the opposite transverse diameter.

The appearance of the tumor and the cut surfaces may be seen in Figs 1 and 2. The following report on the microscopic examination of the tissue was furnished by Dr. Arthur Purdy Stout, Assistant Pathologist to the hospital:

"Gross Specimen. Specimen consists of a firm tumor mass measuring 16 x 13 x 9 cm. The surface for the most part is smooth and glistening, it is somewhat nodular. Cut surface shows a dense white tissue which is made up of numerous interlacing bundles of tissue. Tumor weighed two and a quarter pounds."

"Microscopic Examination (Fig. 3). Section shows bundles and strands of what is apparently fibromuscular tissue. The spaces between these are filled with a rather homogeneous tissue containing elongated nuclei, in places the tumor is exceedingly cellular, and elsewhere there is some evidence of degeneration."

"The Van Gieson stain shows that the tumor is composed almost entirely of fibrous tissue and smooth muscle."

"The Weigert stain shows the absence of elastic fibres." **Diagnosis:** Fibromyoma.

From this report it will be seen that the tumor removed from the subperitoneal space in the anterior abdominal wall was a typical fibromyoma, similar in gross and microscopic appearances to the ordinary fibromyomata so commonly found in the uterus.

To account for the development of this tumor in this unusual location, in the writer's opinion, we can consider only four possibilities. First, that it arose spontaneously from the subperitoneal connective tissue, second, that it developed from the urachus, third, that it was of teratomatous origin, and fourth, that it was an implantation tumor originating from some minute frag-

ment of the primary tumor left in the abdominal incision at the time of the previous operation

Before entering into a discussion or critical analysis of these four hypotheses, I may be permitted to state that, as a result of a fairly diligent but by no means exhaustive search of the literature of the subject, in which I have been aided by the advice of Professor W H Welch of Baltimore, Professor James Ewing of the Cornell Medical School, and Professors Jobling and William C Clarke of the School of Medicine of Columbia University, as well as by a number of our best authorities on gynæcology and abdominal surgery, I have been unable to find a report of a single case of a typical fibromyoma of the abdominal wall I have likewise been unable to discover an authentic instance of a tumor of this variety arising from areolar or fatty tissues in any part of the body, and no record has been found of a fibromyoma developing from the urachus, whether patent or obliterated

These facts, and the recognized impossibility of leiomyomatous tumors developing from tissues containing no smooth or unstriated muscular fibres, would enable us at once to exclude the first hypothesis, that such a neoplasm could spontaneously develop in the subperitoneal areolar and fatty layer of the abdominal wall

In regard to the urachal origin of our growth, one had to be somewhat more guarded, as the urachus is known to contain a definite layer of unstriated muscle, and even after birth these muscular fibres generally can be demonstrated in the fibrous cord representing the obliterated canal The absence, however, of any recorded example of a fibromyoma arising from this structure, and the absence of any evidence in this case of an attachment to anything resembling the urachal cord, would render our second possibility highly improbable

In regard to the third, or teratomatous origin of the tumor, it must be admitted that the median line of the abdomen is a well-recognized habitat for these minute islands of embryonal tissue and numerous examples of teratomatous growths from these rests have been recorded

In all such cases, however, that have been carefully examined, although one type of tissue may preponderate and make up the great mass of the tumor, a painstaking search will always reveal the presence of other types of tissue in some part of the neoplasm The absence in this instance of any evidence of the presence of other types of embryonal tissue would lead one logically to exclude this explanation of its origin

In regard to the fourth hypothesis, that it arose from the implantation, in the line of incision, of a minute fragment of the uterine tumor removed ten years before, the writer is of the opinion that this is by far the most probable and reasonable explanation of its occurrence This opinion is based upon the following facts First, the coincidence of the development of this tumor in an individual who had previously harbored an exactly similar growth in a neighboring structure, second, that in its removal the tumor-bearing organ with its divided and exposed tissues had been for some time



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Fig I

FIG 1 --Photograph of gross specimen--removed from the abdominal wall



FIG 2 —Cut surfaces of tumor

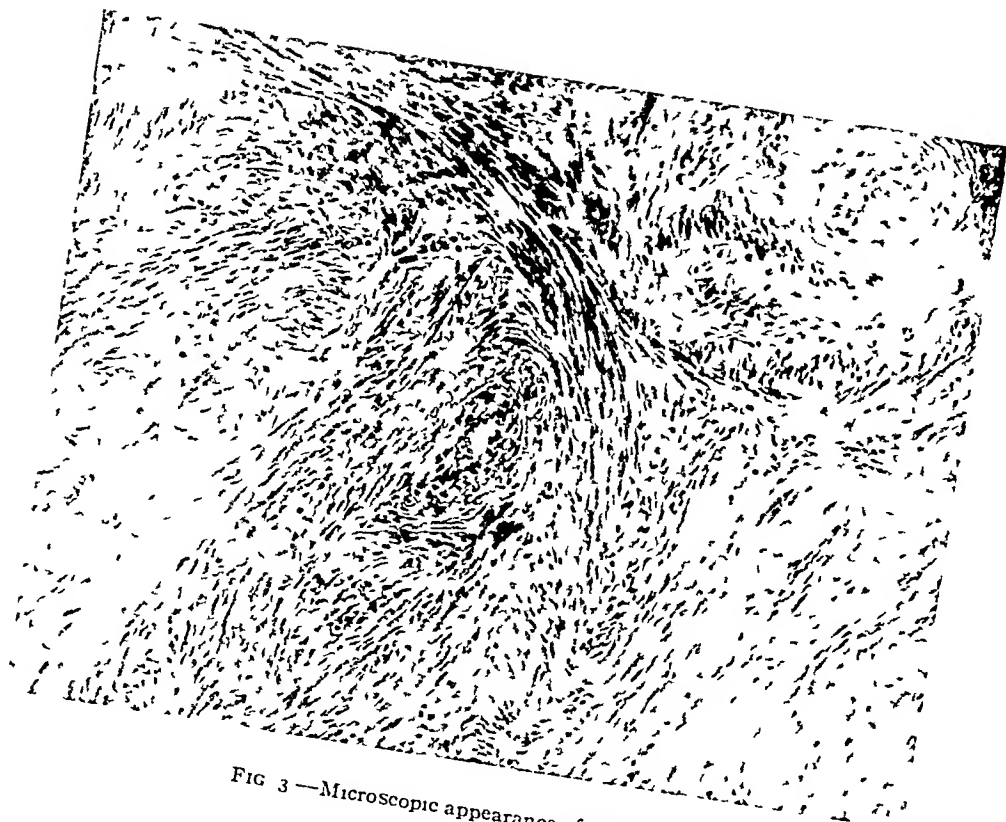


FIG 3 —Microscopic appearance of tumor

FIBROMYOMA OF THE ABDOMINAL WALL

in actual physical contact with the divided and exposed tissues of the abdominal wall, in the exact location in which the secondary growth subsequently developed, third, the well-known and generally recognized fact, that certain cutaneous and mucous membrane tumors which are in close or frequent contact with neighboring tissues, not infrequently give rise to similar growths in the tissues thus exposed, fourth, that modern experimental surgery has furnished innumerable examples of successful grafts of tumor tissue as well as normal glandular structures, in both animal and man, and fifth, that surgical literature records not a few examples of both benign and malignant tumors arising in the immediate neighborhood of incisions previously made for the removal of histologically similar growths, as well as tumors developing from the accidental implantation of aberrant fragments of normal tissues or cells into a new and histologically different environment

As examples of the first may be mentioned the not infrequent development in an abdominal scar, of a malignant growth after operation for the removal of a similar neoplasm of one of the viscera, and the occasional recurrence of ovarian cystomata or adenomyomata after similar procedures

In a recent article by Cullen, published in *Archives of Surgery*, September, 1920, entitled "The Distribution of Adenomyomas Containing Uterine Mucosa," three such cases are reported involving the abdominal wall, one in which the uterus was ruptured during a curettement for abortion with immediate laparotomy for surgical repair of the uterine wound, and two others following operations on the uterus or adnexa

The writer may be permitted to state that his opinion as to the implantation origin of the tumor reported in this communication was greatly strengthened by a personal letter received from Professor Welch, in which the following view was expressed

"I find no difficulty in accepting your suggestion of the origin by implantation of the fibromyoma of the abdominal wall, and this seems to me the most probable explanation. What speaks for the implantation origin in your case is, first, the location, precisely in the scar of incision, and secondly, the obvious opportunity for implantation at the time of the previous operation. Much more complicated tumors, for example, ovarian cystomata, may thus arise by implantation in abdominal scars

"I know of no case identical with yours, and this exceptional occurrence indicates that the conditions for a successful graft by implantation at operation on uterine myomata must be very rarely met, but myomata may develop from cells transplanted from an original tumor, and there is no inherent improbability in my opinion in assuming the similar origin by implantation in your case. I see no reason to think of a possible teratomatous origin."

Although the writer from his limited search of the literature would not presume to claim that the finding of this tumor in this unusual locality was a unique occurrence, still, from the evidence reported, the condition must be one of extreme rarity, and for that reason he has thought it worthy of presentation to this Association

SO-CALLED CONGENITAL DISLOCATION OF THE SHOULDER POSTERIOR SUBLUXATION*

BY ALFRED S TAYLOR, M D

OF NEW YORK, N Y

IT is my belief that there is no such condition as congenital posterior dislocation of the shoulder

Inasmuch as a number of isolated cases have been reported in various journals under this heading, and especially since one well-known surgeon and author has, within the last few years, published a series of papers attempting to prove that birth palsies of the upper extremity are due to such a congenital posterior displacement of the shoulder, it seems worth while to present the evidence against the occurrence of such a lesion, and to try to account for the deformity existing in the cases so reported. It is a striking fact that in each of the cases reported as congenital dislocation there has been evidence of disturbance of the motor nerve supply of the extremity. This disturbance has varied in severity and permanence in the different cases, exactly as in birth palsies of the Erb's type.

Therefore it is the object of this discussion to determine, whether the disability of the extremity is due to primary injury of the shoulder with secondary involvement of the nerves, as is maintained by Thomas, of Philadelphia,⁵ and his followers,⁶ or is due to primary injury of the nerves entering into the brachial plexus.

Against the occurrence of posterior dislocation of the shoulder at the time of birth are the following facts:

There is no recorded case in which the posterior dislocation of the shoulder was found at birth. Since 1914, when Thomas read his paper at the New York Academy of Medicine, I have been looking with especial care at shoulders in these cases and have never found any degree of posterior displacement in a child less than six weeks old. Unfortunately these cases are not usually referred for a surgical opinion until they are several weeks or months old. During the period January, 1914, to April, 1921, there were in my private files records of seventy cases of birth palsy, in all but two (9 and 45, Table 1) of which the condition of the shoulder was carefully noted. Of these sixty-eight cases, twenty-two showed not the slightest degree of posterior displacement of the shoulder. Their ages varied from two days to nineteen years. In the remaining forty-six cases posterior displacement was present in varying degree. Not one of these forty-six cases was less than six weeks old and forty-five of them were eight weeks or more old.

Of the whole sixty-eight only twelve cases were six weeks or less in age. Four were six weeks old, of whom one showed posterior dislocation. In not a single one of the remaining eleven was there any degree of posterior

* Read before the American Surgical Association, June 16, 1921.

TABLE I

Date	Name	Pre-sen-tation	Age	Side and Degree	Dis loc	Op	Findings	Remarks
1 Jan 30 1914 June 28 1917	Green Green	V V	3 wks 3 5 yrs	R++++ R++++	0 +	0 July 2 1917	v & vi torn vii cicatricial	
2 Mar 14 1914	Plumb	V	3 yrs	L++++	+	Mar 23 1914	v vi vii pos- terior disc disappeared 9 months after op	
3 July 7 1914	Lefferts	V	3 wks	L++++	0	Nov 25 1914	v torn off vi and vii cica- tricial	
4 Dec 5 1914	Kachinsky	?	3 mos	I +	+	0		
5 Jan 4 1915	Earnest	V	8 mos	R+	+	0		
6 Jan 18 1915	Hollander	V	5 5 yrs	L++	+	Jan 18 1915	v ruptured vi cicatricial	
7 Nov 10 1915	Klein	Br	6 mos	R++++ eye	+	Nov 10 1915	v almost torn off vi torn comply vii damaged viii & i avulsed	
8 Jan 31 1916	Warner	V	9 wks	R++++ eye	0 1 yr later	Mar 1 1917 Apr 4 1917	Stopped be- cause hemor- rhage v vi torn across No Sever vii cicatrized viii & i avulsed Post disc gone on May 15 18 ex- cept on strong effort to elevate arm forward	
9 May 17 1916	Ioyce	V	10 mos	L+++++	?	May 17 1916	v vi, vii torn & cicatric viii & D i avulsed	
10 Nov 10 1916	Whiting	V	3 mos	R+++++ eye	+	0		
11 Feb 2 1917	Kilpatrick	V	2 mos	L++++	0	0		
12 Feb 12 1917	Dennis	Br	2 days	R+	0	0		
13 Mar 6 1917	Rigby	?	12 yrs	R+++++	+	Mar 12 1917	v vi torn across Sep 1 cm, bulbous, vii 2-3 dam- aged viii & i scar pressure	
14 Mar 19 1917	Delprate	V	6 wks	R++++	0	0		
15 Apr 27 1917	Lillcrapp	V	8 mos	L+++	0	0		
16 June 2 1917	Barry	V	6 mos	L+++++ eye involved--	+	June 5 1917	Long scar v vi vii viii Di	2nd op Nov 18, 1919
17 Sept 4 1917	Christ	V	2 mos	R+ v & vi	+	0		Made a complete spontane- ous reco- very with reduction of the sub- luxation

TABLE I—Continued

Date	Name	Pre-sen-tation	Age	Side and Degree	Dis loc	Op	Findings	Remarks
18 Oct 17 1917	Weaver	V	5 5 yrs	R++++	+	Oct 26 1917	Sever v vi about ½ torn vii ½ torn off	
19 Oct 26 1917	Greenberg	V	4 mos	R++++ eye	+	o		
20 Dec 26 1917	Merila	Br	6 wks	R++++	+	Apr 16 1918	v & vi torn	
21 Feb 1 1918	Dilber	V	3 mos	L+++	+	Feb 8 1918	v torn off vi & vii cicatricial viii & Di	
22 Feb 12 1918	Van Dine	V	3 5 mos	R++++	+	Apr 11 1918	v vi vii re- sected No Sever 2 yrs later almost compl reduc- shoulder spont	
23 Apr 6 1918	Carey	V	3 ¼ mos	L++	+	Apr 6 1918	cv torn off	almost perfect recovery
24 Apr 30 1918	Sloben	V	10 days	L++++	o	o		
25 May 17 1918	Eskwith	V	2 ½ yrs	R+	+	o		
26 June 4 1918	Porta	V	3 mos	L+++	+	o		
27 June 17 1918	Corbally	?	14 yrs	L++	+	Nov 30 1918	C v & vi	
28 June 17 1918	Tetamore	Br	2 wks	R+++	o	o		
29 June 20 1918	Fitzgerald	Br	7 wks	L+ R++	o o	o o		
30 June 27 1918	Silverman	V	5 yrs	R+++ eye (very little power)	o	o		
31 Aug 2 1918	Silvagio	V	2 & 4 mos	R++++ eye	+	Dec 14 1918	v vi vii viii & i damaged Died of hem- orrhage on table	
32 Nov 14 1918	Rosenbloom	V	26 mos	R+++	+	o		
33 Nov 15 1918	Margules	V	2 ½ yrs	R+++	+	June 1918	Op done by another surgeon who exposed plexus but did not attempt any repair	
34 Feb 6 1919	Carlson	V	2 ¼ yrs	R+	+	Feb 19 1919	C v & Vi	
35 Feb 20 1919	Zucker	?	19 yrs	L++++	o	o		
36 Mar 7 1919	Kalmanowitz	V	2 mos	R++++	+	o		
37 Apr 23 1919	Levas	Br	4 mos	R+++	+	o		
38 Apr 29 1919	Rubino	V	22 mos	R++++	+	June 2 1919	v vi torn across vii torn almost across viii torn across Di normal	

TABLE I —Continued

Date	Name	Pre- sen- ta- tion	Age	Side and Degree	Dis loc	Op	Findings	Remarks
39 May 20 1919	Shusteroff	Br	7 yrs	R (spontan cure) L just shoulder remnants com- ply paralzd	o o	o		
40 May 26 1919	Nobile	Br	3 mos	R + + + +	+	June 7 1919	v vi & vii torn across Bulbs, viii & i com- pressed	
41 June 17 1919	Allensohn	V	14 mos	R + + + +	+	o		
42 July 21 1919	Rifkin	V	7 5 yrs	L + + + +	+	o		
43 Oct 16 1919	Nagelsmith	?	16 yrs	R + + + + + eye	+	Jan 23 1919	v torn across vi almost vii ganglion of root extra- spinal viii & i avulsd	
44 Oct 30 1919	Waldman	V	19 mos	L + + + + eye	+	Jan 26 1920	v vi torn apart viii most- ly torn apart viii & i cica- tricial into foramina No Sever Closed reduction 9 mos almost no dislocation remaining	
45 Oct 30 1919	Lotz	Br	3 5 yrs	L +	?	o		
46 Oct 31 1919	Glantz	V	2 5 mos	R + + + + Cviii & Dieye	+	o		
47 Dec 26 1919	Lonetti	Br	6 wks	L + + + +	o			
48 Dec 31 1919	Bettcher	Br	7 wks	R & L + + + R normal in 10 days	o	o		
49 Jan 19 1920	Sately	Br	9 wks	L + +	o	o		At 4 mos had post sublux of shoulder which had d appeared at 9 mos with im- provement of muscles
50 Feb 20 1919	Johnson	Br	8 wks	R + + +	+	o		
51 Mar 12 1920	Teall	V	9 mos	L + + + +	+	Mar 22 1920	v vi, vii 2½ cm densescar tear viii & i constricted No Sever Post-op sub- coracoid dis- location	
52 Mar 17 1920	Sable	V	5 5 wks	R +	o	o		
53 Mar 24 1920	Johnstone	V	6 yrs	R + + +	+	Apr 3 1920	C v & vi half torn through	
54 Apr 8 1920	Bernd	V	10 wks	L + + +	Very slight +	o		

TABLE I—Continued

Date	Name	Pre-sen-ta-tion	Age	Side and Degree	Dis-loc	Op	Findings	Remarks
55 Apr 23 1920	Post	V	2 days	L+	o	o		
56 May 17 1920	Cucumber	V	7 mos	L++++	+	o		
57 June 9 1920	Everson	V	15 mos	L+++ Cviii & D1 eye	+	o		
58 June 23 1920	Ackerholt	V	5 mos	R++++ eye small	Very slight +	o		
59 Oct 18 1920	Conroy	V	5 yrs	R+ mild	+	o		
60 Oct 20 1920	Mauersberger	V	10 mos	R++	+	o		
61 Oct 21 1920	McLoughlin	V	16 mos	L++++ eye	+	Mar 23 1921	v, vi vii viii & D1 torn & cicatricial	Eye showed slight enophthalmos and narrowed palpebral fissure suggesting avulsion of D1 & Cviii Hand also flabby and contracted
62 Nov 16 1920	Weinberg	V	5 days	L+++	o	o		
63 Nov 29 1920	Levine	V	2 1/2 mos	R++++	+	o		
64 Dec 9 1920	Blackman	V	4 5 mos	R++++	+	o		
65 Jan 19 1921	Feltman	V	6 5 mos	L++++	+	o		
66 Jan 25 1921	Cooper	V	6 wks	L+++	o	o		
67 Feb 9 1921	Kirschbaum	V	2 mos	L++++ eye involved	+	o		
68 Mar 1 1920	Mooney	V	2 5 years	R++	o	o		Pectoralis major atrophied and not contracted
69 Mar 18 1921	Benedito	V	2 mos	R++++	o	o		
70 Mar 20 1921	Osterman	V	14 mos	L++++ eye sl. invol-ved	+	o		

Key

Vertex = V
 Breech = Br
 Unknown = ?
 Date = First time seen
 Age = Age at first observation
 Side & Degree = + to +++++ indicating in a general way the degree of disability
 Eye or Eye involved = Narrowed palpebral fissure (Same side as palsy) slight enophthalmos and smaller eye usually indicating injury of Cvii & D1 close to foramina or avulsion from cord
 Dislocation = + = present (Sometimes absent at first exam and present some weeks later)
 = o = absent
 = o = not done
 Operation = when done = Date of operation
 Findings v, vi vii viii = Cervical nerves D1 = Dorsal nerve
 Constricted = Nerves compressed by scar tissue
 Sever and No Sever indicate whether or not pectoralis major and subscapularis were divided to get reduction of dislocation
 Torn and cicatricial nerves resected and sutured constricted nerves freed

CONGENITAL DISLOCATION OF THE SHOULDER

displacement Diligent inquiry among the obstetricians in three of the large lying-in hospitals in New York City elicited the fact that not one of them had ever seen a posterior subluxation of the shoulder *at the time of birth* in any one of the birth palsies of Erb's type which had occurred in their services

Dr Edward D Truesdell, connected with the New York Lying-in Hospital, saw every case of birth injury of whatever type during a period of ten years, and involving about 30,000 deliveries, and in all injuries of extremities made roentgenograms at intervals In a personal communication he states that among the thousands of infants delivered there were many cases of birth palsy of Erb's type, but that he never saw a single one in which there was any degree of dislocation of the shoulder During this period he was getting the material for his admirable book on "Birth Fractures and Epiphyseal Dislocations," so that he examined these shoulder joints with minute care He is a well-trained surgeon and therefore a competent observer Incidentally he states that there was never epiphyseal separation of the upper humerus associated with Erb's palsy in his experience

Dr H McM Painter, for years connected with the obstetric division of the Nursery and Child's Hospital and the Sloane Maternity Hospital, verbally states that he has never seen a birth palsy with an associated posterior subluxation of the shoulder *at birth*, and that he has called in another surgeon in every injury case in order to check up his own findings

A diligent search over a period of seven years has failed to find a single authentic case in which a birth palsy has been associated *at birth* with any degree of posterior displacement of the upper end of the humerus Even Thomas, who has built up his theory that "birth palsy is the result of posterior dislocation of the shoulder, with secondary nerve injury, rather than the result of primary plexus injury," states that he has never happened to see a posterior dislocation present in an infant less than three weeks old The paralysis, on the contrary, is present in all cases at birth

From the evidence presented, it is fair to conclude that there is no such condition as "congenital posterior dislocation of the shoulder" and therefore it cannot be the cause of the "birth palsy of Erb's type" The term congenital, in this connection, should be discarded

Nevertheless, in the sixty-eight children above tabulated (Table 1) some degree of posterior dislocation of the shoulder was present in forty-six (or 68 per cent) The youngest child to show it was six weeks old There were sixty children in the series six weeks or more of age, and of these forty-six (or 77 per cent) showed the dislocation If no dislocations appear until the age of six weeks, and above that age appear in 77 per cent, the deformity must develop as a sequel to the primary injury causing the paralysis, which is unquestionably damage of the brachial plexus

The conviction that injury of the brachial plexus is the primary cause of the paralysis results from consideration of the following facts

The paralysis is present at birth Dislocation is absent

The distribution of the paralysis is always characteristic of a *root* lesion

rather than a lesion of peripheral trunks after they leave the plexus, which latter would be the case if the paralysis resulted from injury secondary to shoulder dislocation. The distribution of the paralysis in Erb's palsy is so characteristic that a little familiarity enables one to predict fairly accurately which roots are damaged in a given case.

In a considerable number of operations (seventy-six in my private files, including also cases 1903-1904) the lesion in the great majority of cases involved the upper roots of the plexus chiefly, and there was a relatively wide area of normal tissues between it and the region of the shoulder joint and there was no cicatricial tissue in the axilla. In only a very few cases in which the entire plexus was damaged did the resulting cicatricial tissues extend downward to the shoulder joint region.

Thomas states that no case is on record where, at operation, a lesion of the nerves was found other than cicatricial induration which he believed was secondary to shoulder joint injury. In the October, 1905, *American Journal of Medical Sciences* (Clark, Taylor and Prout), Case III, it was recorded that the outer trunk coming from the junction of the fifth and sixth roots was torn off and displaced downward and inward 2.5 cm and was adherent to neighboring muscle.

In the series of seventy cases seen since 1914, twenty-five were operated upon, and reference to the findings shows (Table I) that in many instances nerves were more or less completely torn across.

This type of injury could not possibly result from cicatricial infiltration of nerves secondary to injury of the shoulder joint (Figs 1 and 2).

In two cases, No. 43 in the above group, and an infant named Passamero, operated upon at the Babies' Hospital in October, 1912, a posterior root ganglion was present in the cicatricial tissue well external to the foramina. This indicated avulsion of roots from the cord.

Through the courtesy of Drs. L. A. Wing and Losee of the Lying-In Hospital, the following case is put on record:

Mila. Confinement No. 77647. Born December 15, 1920. It was a Footling presentation, with threatened prolapse of the cord. Breech extraction was rendered difficult by a moderately contracted pelvis. No instruments were used. The general condition was good for twenty-four hours, after which signs of intracranial injury appeared and death occurred on the fifth day.

At birth, paralysis of both upper extremities was noted.

Right side. There was a fracture of the clavicle. The entire extremity showed flaccid paralysis except for very slight movement in the fingers.

Left side. There was complete flaccid paralysis. Autopsy showed extensive intracranial hemorrhage, with extension of the clot down the spinal canal, fracture of the right clavicle, *both shoulder joints perfectly normal*, both brachial plexuses macroscopically normal outside the intervertebral foramina, and avulsion of the roots of C IV and V from the cord on the left side. These roots lay outside of the dura. (See Figs 3 and 4.)

The case of Boyer⁴ is equally convincing and more interesting.

On July 4, 1905, during an attempt to deliver the aftercoming head through

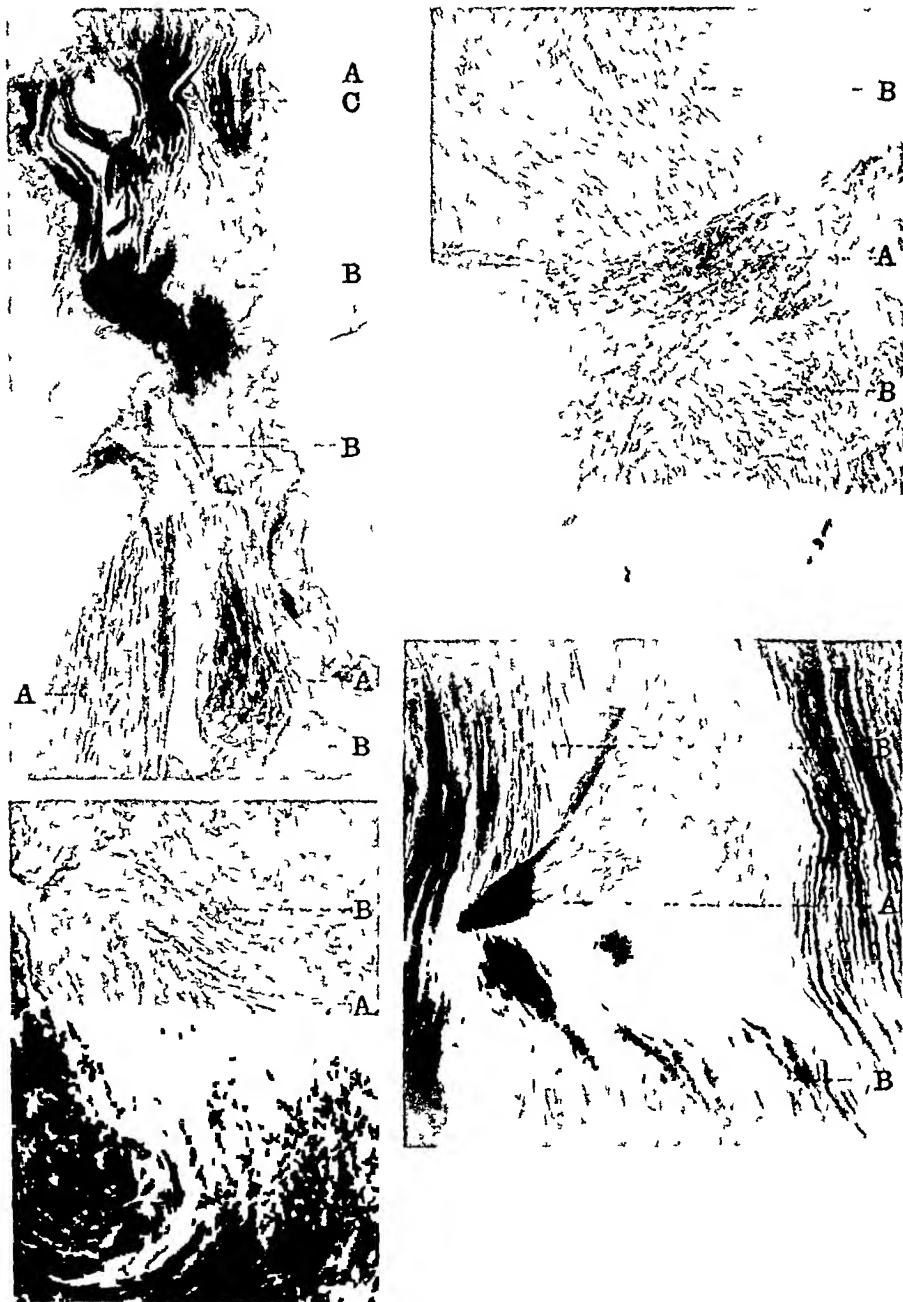


FIG 1 —These are microphotographs of nerves resected in the early cases of the operative series. The lesions were all located between the intervertebral foramina and the distal end of the plexus. No mere infiltration of the nerves by material from an injured shoulder joint (as suggested by Thomas) could possibly cause the results pictured. The very black lines represent nerve fibres more or less damaged and the rest is cicatricial tissue.

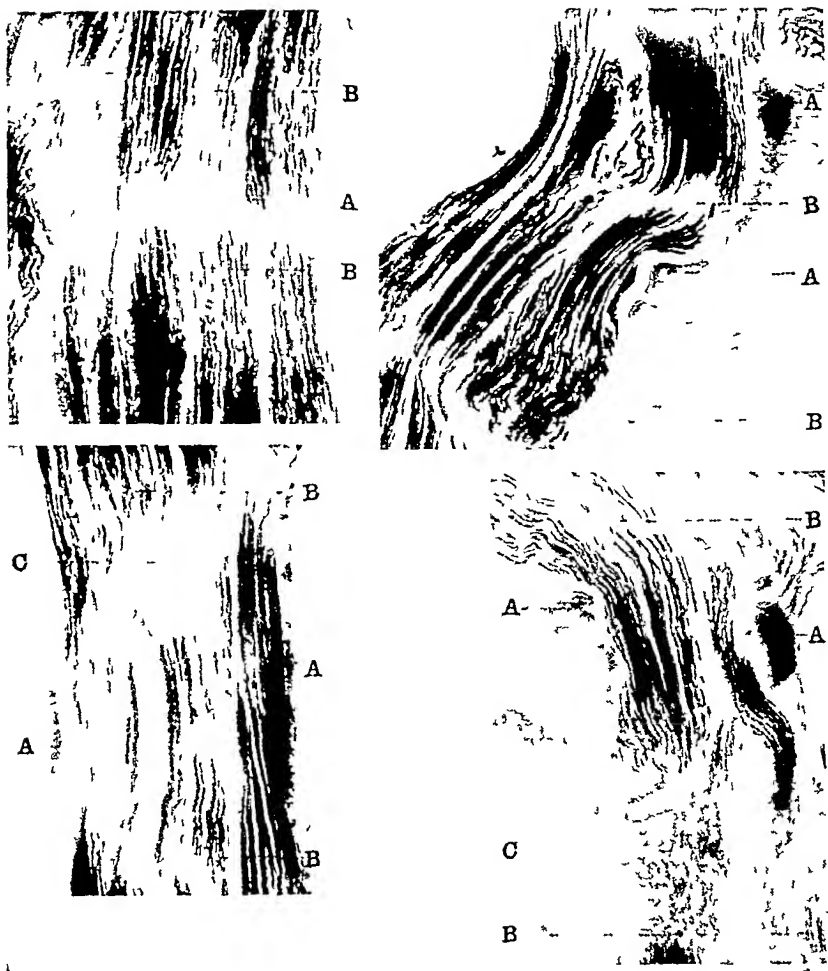


FIG 2—These are microphotographs of nerves resected in the early cases of the operative series. The lesions were all located between the intervertebral foramina and the distal end of the plexus. No mere infiltration of the nerves by material from an injured shoulder joint (as suggested by Thomas) could possibly cause the results pictured. The very black lines represent nerve fibres more or less damaged and the rest is cicatricial tissue.

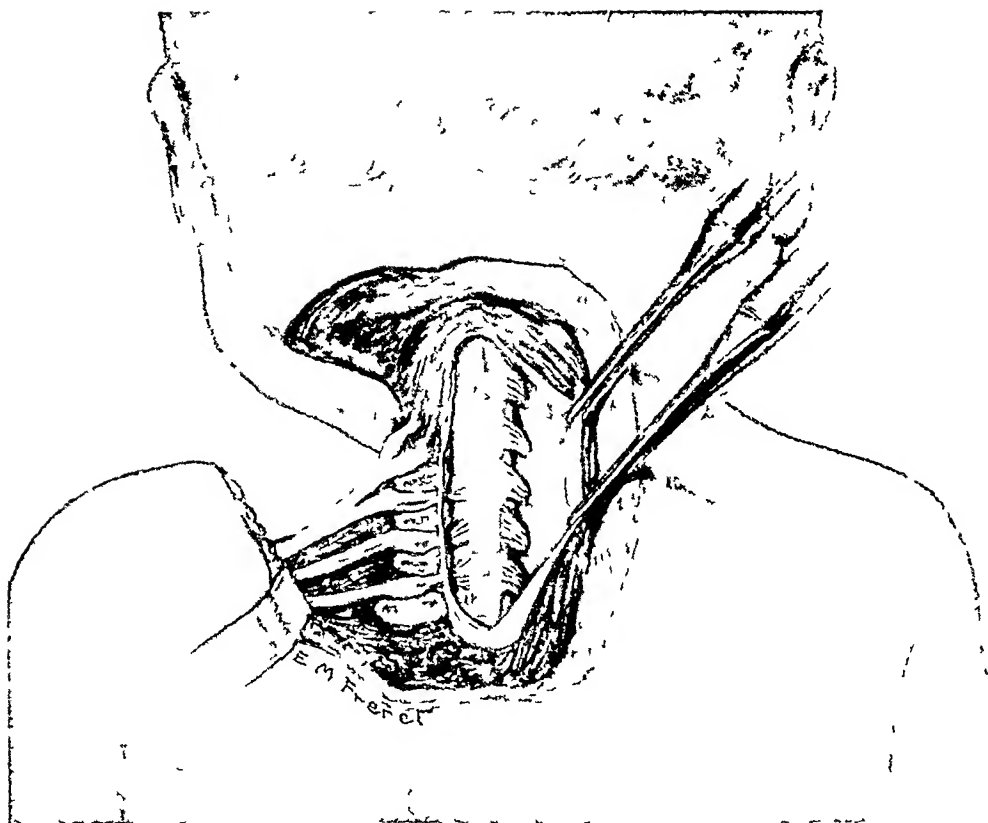


FIG 3 —The subject was injected with and submerged in ten per cent formalin solution. The plexus and spinal cord are exposed by dissecting away the soft tissues, removing the posterior-vertebral arches and opening the dura. Note all the roots present on the right side of the cord and that two C IV and V have been avulsed from the cord on the left side, including both sensory and motor roots. The torn ends of the two roots were extradural. The cord itself was so smooth that the actual site from which the posterior roots were avulsed could not be seen. There was no apparent injury to or deformity of the cord.



FIG 4 —Same infant as in FIG 3 showing the left brachial plexus apparently intact in its extraspinal portion. The right plexus also appeared normal extraspinally.

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a contracted pelvis, the right plexus was felt to give way under the finger, passing over the right shoulder. A right-sided birth palsy was prophesied before the delivery, and it appeared in typical form when delivery was completed. No posterior dislocation of the shoulder was present and no injury had occurred to the shoulder joint. Two hours after birth a severe convulsion was followed by death. The body was injected with 10 per cent formalin solution and then was immersed in a jar of similar solution. After complete hardening the right brachial plexus was exposed and excised completely from foramina to upper axilla. A typical lesion from overstretching was present at the junction of the fifth and sixth roots. The pathology present was described and pictured in a microphotograph by Dr T P Prout in the *Journ A M A*, January 12, 1907, xlviii, pp 96-104.

In twenty plexuses (*Am Journ Med Sc*, October, 1905, Clark, Taylor and Prout) in infants still-born or dying shortly after birth, typical lesions were produced by forcible separation of the head and neck from the corresponding shoulder. It so happened that in seven of the twenty the root of C vi was avulsed from the cord and the ganglion of the posterior root lay outside the spinal foramen.

Avulsion in the experimental cadaveric cases occurred in a much higher percentage than seems to be the case in the clinical series. The percentage is difficult to determine in the clinical series inasmuch as laminectomy would be necessary, and is not justifiable, to decide the question (see Figs 3 and 4).

These facts taken together prove conclusively that the primary cause of brachial birth palsy is damage to the brachial plexus. The etiology, mechanism and pathology were fully worked out in the original publication in 1905 previously referred to, and nothing in later experience has caused a change in the views there expressed.

Assuming that the primary lesion is a brachial plexus injury, the later appearance of posterior subluxation of the shoulder in 68 per cent of these children means that there is a distinct cause-and-effect relation between the nerve lesion and the dislocation, which must be worked out for the sake of preventive and curative treatment. (Also see Fairbank²)

In the shoulder joint of the newborn infant the glenoid fossa is very shallow and in some instances is almost convex, the joint capsule is quite loose (Figs 6, 7, 8 and 10). Therefore, outside of atmospheric pressure which plays a minor rôle, the only structures that hold the upper end of the humerus and the glenoid fossa in their proper anatomical relations are the muscles that pass over and surround the joint. This is the view generally held by anatomists. Through the courtesy of Dr Lucius Wing of the visiting staff of the New York Lying-In Hospital, an interesting demonstration of the above fact was possible. Some twenty infants were examined. When they were asleep and the shoulder muscles completely relaxed, the upper end of the humerus could be displaced backward, forward, outward or downward with ease, for a distance of 1 to 2 cm, but as soon as the infant woke up and resisted, none of these displacements was possible except by the use of undue violence.

If the muscles surrounding the shoulder joint are responsible for the main-

tenance of correct anatomical relations between the two bones entering into it, then it follows that the activities of the various muscles must be very nicely balanced against each other in order always to hold the two bones properly together in the various attitudes of the joint. It would therefore be expected that if one or more of these muscles were paralyzed, while others remained active, the balance would be so disturbed that deformity of some sort would result. If the muscles involved were only partially paralyzed the disturbance of balance might be so slight that no displacement would result. If all the muscles were partially paralyzed to the same degree there would be loss of strength in the joint but no disturbance of balance and no displacement would occur. If all the muscles were completely paralyzed there would be complete loss of power, a flail joint would result and gravity would determine the displacement.

In a series of children with birth palsies one can always find examples of these various degrees of disturbed balance. Except in flail joint the displacement in nearly every case is backward, quite the opposite of the usual traumatic dislocation of the shoulder.

The most marked dislocations have in this series been observed in the older children where complete paralysis of the *spinatus* and *teres minor* had persisted and where *biceps* and *coraco-brachialis* had regained considerable power, as had also *pectoralis major* and *subscapularis* but in these last two there had developed marked contracture.

The mechanism of the posterior displacement is as follows.

The *infraspinatus* and *teres minor* form the chief posterior buttress of the shoulder joint and, being innervated by two upper roots of the plexus, they usually suffer the most complete and lasting paralysis. *Pectoralis major*, *teres major* and *latissimus dorsi* being only partially paralyzed rotate the humerus inward, and thus overstretch the paralyzed posterior muscles. *Teres major* and *latissimus dorsi* also exert traction backward on the humerus. When *subscapularis* partly escapes paralysis or regains its function it also causes inward rotation and slightly backward traction on the humerus (Fig 6). *Pectoralis major* and *subscapularis* being only partially paralyzed and having only paralyzed antagonists first undergo functional shortening and then organic contracture. The head of the humerus is thus gradually forced backward, overstretching to a still greater extent the paralyzed posterior muscles.

Finally, when the posterior subluxation is present, it is greatly exaggerated during attempts of the patient to elevate the extremity. *Pectoralis major*, *coraco-brachialis*, and *biceps*, when it has recovered somewhat, carry the humerus forward and upward, but at the same time cause a thrust upward and backward along its longitudinal axis, which visibly increases the subluxation of the head of the humerus.

In a small number of cases it has been stated that while a well-marked posterior subluxation of the shoulder is present, all the muscles of the extremity react to the faradic current, that therefore there is no persisting

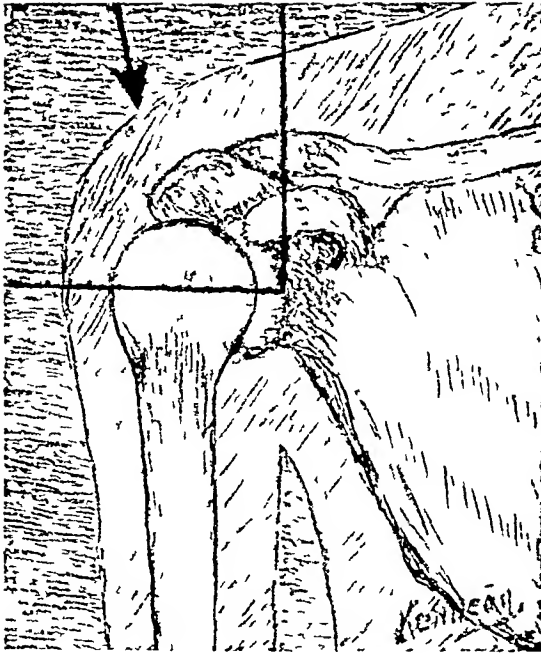


FIG 5 —Shows the planes of section of the right shoulder in very young infant. The right angled upper outer portion of the shoulder was removed en bloc giving the exposure for FIGS 6 7 and 8

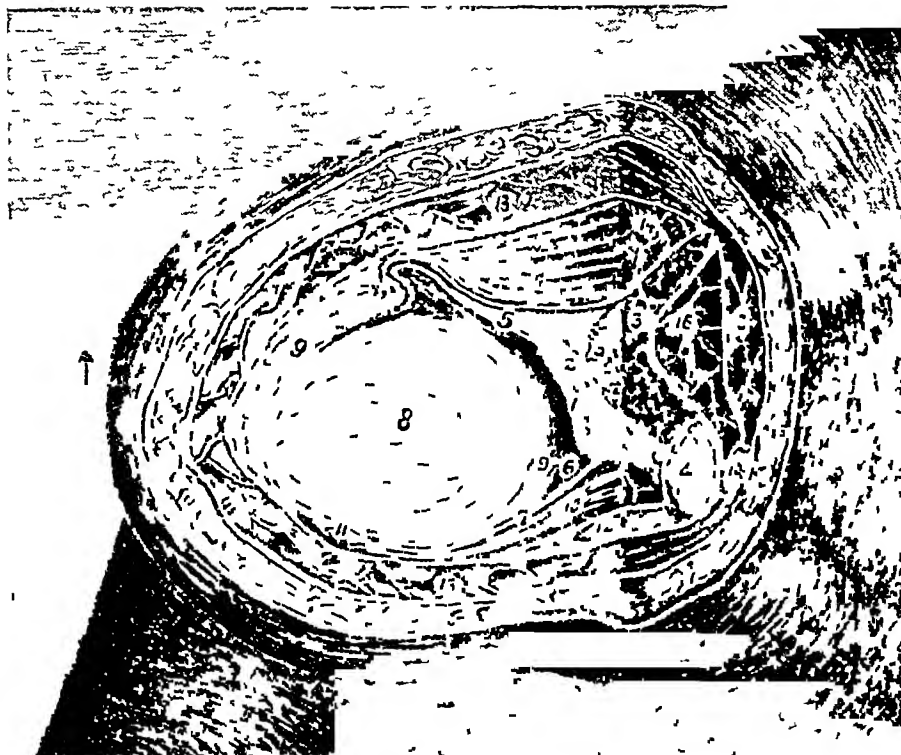


FIG 6 --The arrow indicates that the humerus is rotated outward showing relaxation of posterior capsule and muscles 1 Glenoid cavity Note the nearly flat contour 2 Cartilaginous bed of glenoid 3 Scapula showing ossification Note shapes of cartilaginous bed and ossified portion of scapula 4 Coracoid process Sectioned obliquely 5 Posterior border of glenoid cartilage merging into posterior capsule 6 Inferior portion of capsule 7 Anterior capsule 8 Head of humerus sectioned horizontally (See FIG --) 9 Serous surface of head of humerus with deltoid bursa externally 10 Subscapularis muscle Note that it pulls somewhat backward as well as inward 11 Biceps tendon long head 12 Biceps short head and coraco-brachialis 13 Deltoid muscle 14 Infraspinatus muscle 15 Clavicle 16 Supraspinatus muscle

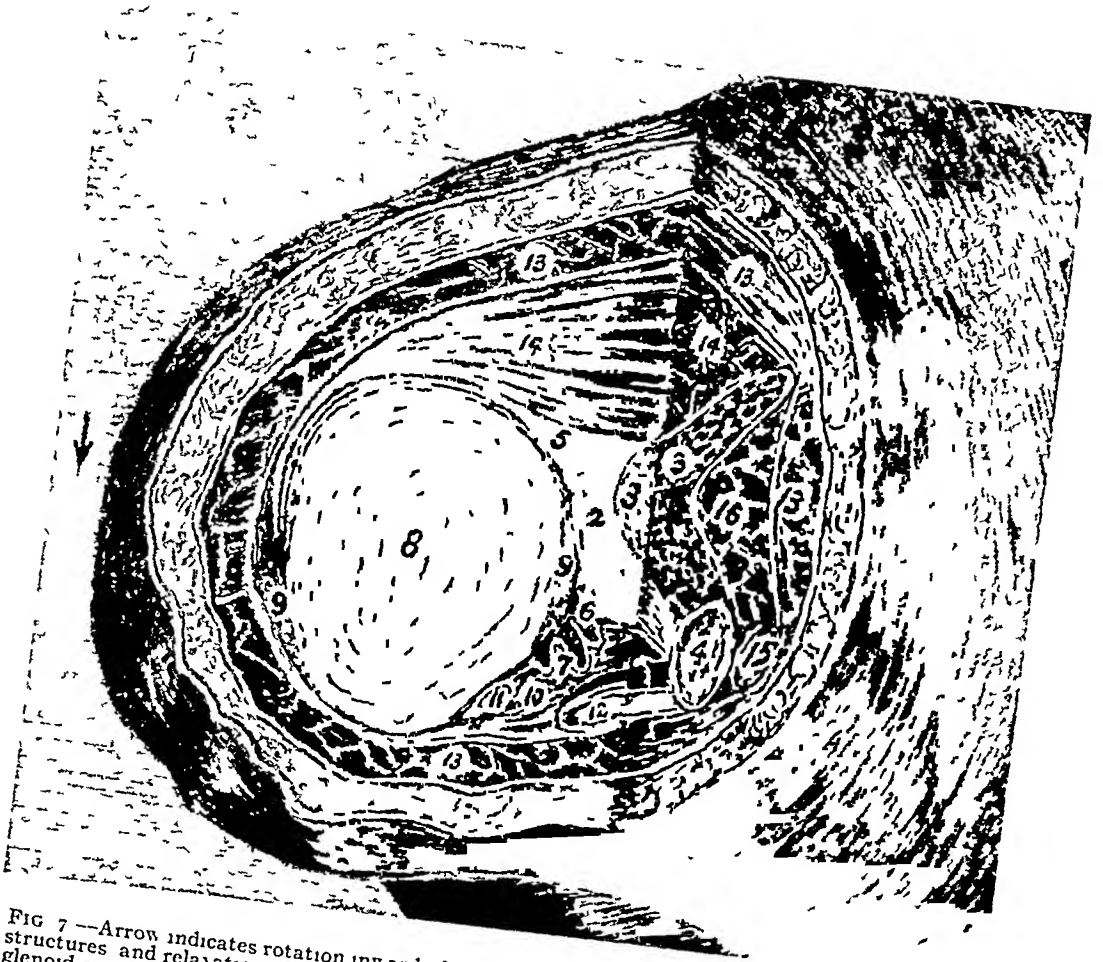


FIG 7 —Arrow indicates rotation inward of the humerus showing stretching of the posterior structures and relaxation of the anterior capsule and subcapularis muscle. The portion of glenoid cartilage at 5 is very flexible and causes practically no obstruction to posterior displacement of the head of the humerus.

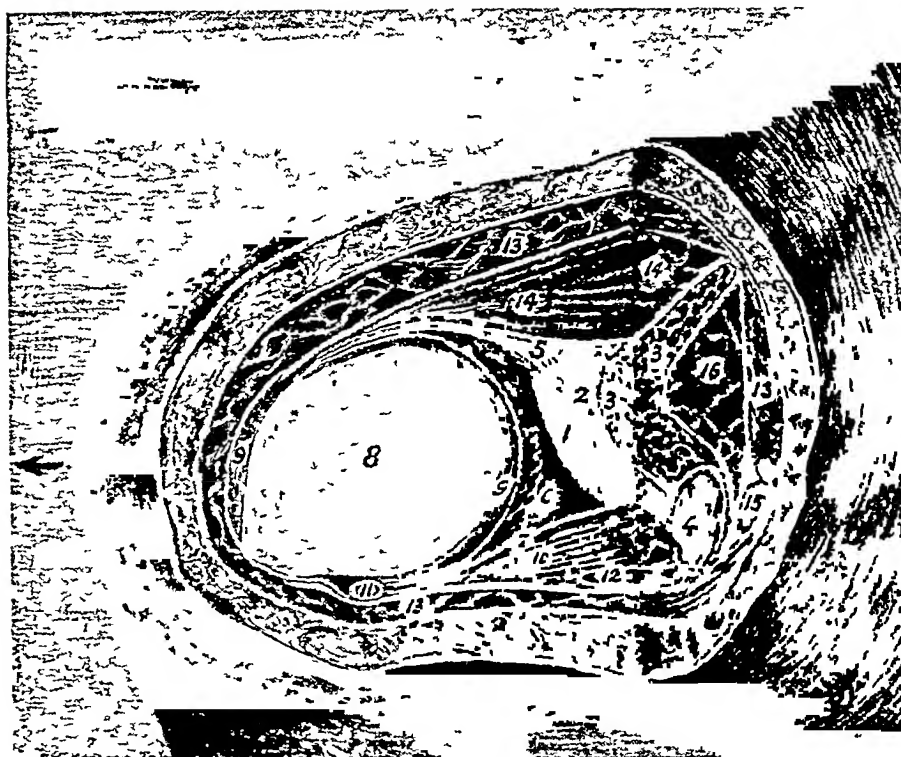


FIG 8 —Arrow indicates pull outward on head of humerus by manipulating the shaft of the bone Note the wide separation of the joint surfaces even in the face of rigor mortis
Numbers are the same as in FIG 7

CONGENITAL DISLOCATION OF THE SHOULDER

paralysis, and therefore the dislocation cannot be the result of a paralysis due to nerve injury. Since this apparently paradoxical condition is seen only in children one or more years old, it can readily be accounted for on the basis of the mechanism previously presented.

The dislocation appears usually in from six weeks to three months, and is always associated with marked inward rotation of the humerus, and with contracture of the pectoralis major and subscapularis. These contractures are usually so marked that the humerus cannot be rotated outward passively, even by the use of much force, so that the flexed forearm will come to the sagittal plane, *i e*, less than 50 per cent of its normal. Therefore the external rotators are continuously overstretched, and even if nerve supply regenerates sufficiently to give faradic reaction, they nevertheless suffer a constant relative handicap, the muscular imbalance persists and the dislocation remains. If in addition the coracoid has grown forward and downward it adds a permanent obstacle to spontaneous reduction. The persistence or disappearance of the dislocation depends upon whether or not the external rotators can overcome their handicap, and whether or not the coracoid interferes. The majority of them persist.

A number of very young infants have been seen with birth palsy in whom no sign of dislocation was present. After several weeks or months, during which parents have failed to follow advice, they have again appeared with definite posterior displacements. Warner⁸ and Sately⁴⁰ in this series.

In one case in this series Sately,⁴⁰ first seen at nine weeks of age, showed no dislocation, at four months showed definite posterior displacement, and then, going on to a spontaneous nerve and muscle regeneration, returned at nine months with no sign of posterior displacement. This is perhaps the most convincing argument of all that the displacement is the result of disturbing the balance in the action of the shoulder joint muscles.

In several cases of this series where well-marked dislocation was present before operation, and where at operation nothing except a nerve repair was done, post-operative recovery of the nerves and associated muscles has been accompanied by a spontaneous gradual reduction of the displacement.

Van Dine,²² Warner,⁸ Plumb,² Waldman⁴⁴ Table I

It therefore seems fair to deduce from the material presented that there is no such entity as congenital posterior dislocation of the shoulder, and that in the cases so reported the dislocation is a delayed sequel of a primary nerve injury, which has caused an unevenly distributed paralysis in the muscles about the shoulder joint. The resulting unbalance leads to the development of the dislocation.

Treatment is primarily prophylactic, for this dislocation need not occur if the paralyzed extremity is properly treated from the beginning. Maintenance of correct posture is fundamental, as this prevents both the overstretching of the paralyzed muscles and the contracture of the non-paralyzed or partially paralyzed antagonists. The best posture consists in abduction of the arm to 90 degrees or more, external rotation of the humerus until the

flexed forearm is in the vertical plane, flexion of the elbow to 90 degrees or less, complete supination of the forearm, and extension of the wrist and fingers (Fig 11) This posture is almost perfectly attained if the palm of the opened hand is held on the vertex of the skull with the elbow held out in the transverse plane of the body, and may be maintained by any one of a great variety of methods Moreover this posture helps mechanically to prevent posterior displacement of the shoulder, and causes relaxation of the nerves which have been damaged by overstretching and so favors their spontaneous recovery to the maximum degree After the first two or three weeks, during which manipulation is very painful, the extremity should be removed from its fixation two or three times a day and given massage and passive motion

In appropriate cases, at the proper time, surgical repair of the damaged nerves should be done There is much and heated argument as to what cases are appropriate and what time is proper for surgical repair, and the question is by no means settled The author's opinion is a matter of repeated record, and is modified by later experience only to the extent that a longer period between birth and operation is permissible provided correct care, as above indicated, is continuously given

In those cases in which the dislocation has occurred it may be readily reduced by the method of Sever³ Nerve repair may be done at the same time Whitman's method, which consists in stretching, rather than cutting, the contracted muscles, followed by fixation, is not so satisfactory, as there is a strong tendency to recurrence of the dislocation Moreover, in many of the cases the tip of the coracoid process has become elongated forward, and especially downward, so as to mechanically interfere with complete replacement of the head of the humerus This elongated tip must be resected supperiosteally to attain the best result Occasionally it is also necessary to do osteoplasty on the acromion process because of a similar distorted overgrowth

In any case, whether operated upon or not, the fixation and physical therapeutics above outlined must be continued until the paralyzed muscles and damaged nerves have recovered sufficiently to prevent the muscular imbalance which would otherwise result in posterior subluxation

SUMMARY

Since there is no case on record where in a birth palsy case a posterior subluxation of the shoulder has been found *at birth*—since obstetricians connected with three of the large lying-in hospitals of New York City have never seen a single instance of the association of the two at birth, since, after a search during seven years, the author has never been able to find posterior subluxation in any birth palsy case less than six weeks old—he is forced to believe that “congenital posterior subluxation of the shoulder” does not occur in birth palsy cases and therefore cannot be the cause of the palsy

The term “congenital” should be discarded in this connection

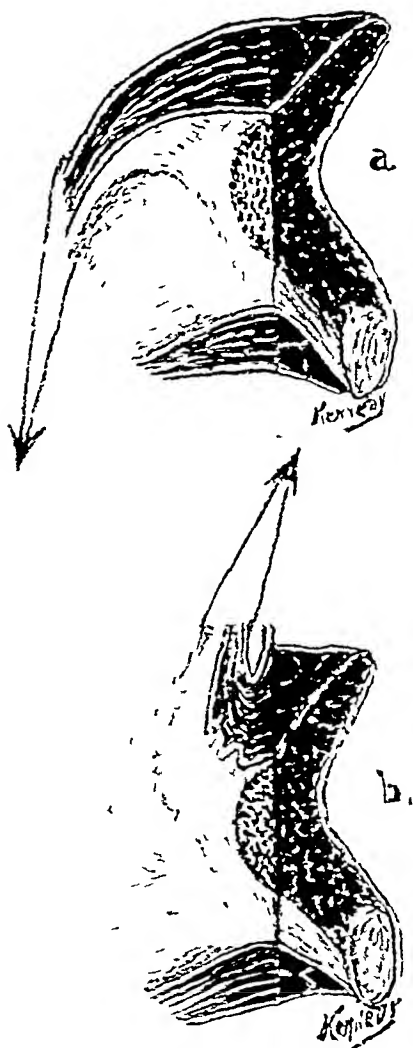


FIG 9 —The arrows show the effect of pull on the posterior portion of capsule and glenoid cartilage indicating how slight is the resistance to posterior displacement of the head of the humerus



FIG 10 --Left shoulder in very young infant with muscles lifted away and head of humerus pulled outward showing free displacement without injury to capsule (The muscles are the chief factors in maintaining the joint surfaces in proper contact in the different attitudes of the extremity) 1 Head of humerus drawn laterally and downward 2 Coracoid process 3 Lateral end of clavicle 4 Acromium 5 Glenoid cavity Anterior margin 6 Tendon of long head of biceps 7 Tendon of short head of biceps and Coraco--brachialis M 8 Tendon of Pectoralis minor 9 Tendon of Triceps M 10 Deltoid muscle turned back 11 Deltoid bursa 12 Anterior portion of capsule 13 Coraco acromial ligament 14 Superior portion of capsule



FIG 11 —Shows an older child held in the desired position by the author's brace. This happens to be a post-operative case and therefore the head is harnessed to prevent traction on the sutures.

CONGENITAL DISLOCATION OF THE SHOULDER

Since the author's series shows no dislocation present up to six weeks of age, but shows its presence in 77 per cent of the sixty cases six weeks or more old, it is obvious that the dislocation is a sequel of the paralysis

That the paralysis results from nerve injury is evidenced by these facts

Nerve lesions have been found and resected in a large number of operative cases (Figs 1 and 2), where they could not have been the result of injury to the shoulder. The area of cicatricial nerve damage was widely separated from the shoulder joint structures which appeared of normal texture except for the contracture in some of the anterior muscles

The nerves were torn across, avulsed from the cord, or shredded and cicatrized

Lesions precisely similar to those found at operation have been experimentally produced on the infant cadaver

In one case the plexus was felt to give way under the author's fingers and at birth there was a typical palsy, no disturbance of the shoulder was present, and autopsy showed a nerve lesion precisely similar to the experimental and operative ones

Figs 3 and 4 show a distinct nerve lesion in a case of bilateral palsy, where neither shoulder showed dislocation or other injury, either clinically or at autopsy

The posterior dislocation is a sequel to the unbalanced paralysis of the shoulder muscles, and may be prevented in most cases by proper treatment

The external rotators (posterior muscles) suffer the most complete paralysis, and are continuously overstretched by the internal rotators which are usually not completely paralyzed and eventually develop organic contracture, with the result that the head of the humerus is gradually displaced backward

Treatment of the dislocation is

Preventive —By maintaining correct posture and using physical therapeutics from the time of birth until the muscle balance is sufficiently restored

Surgical —Nerve repair when indicated, supplemented by the Sever operation when the dislocation is irreducible. These operations are to be followed by postural treatment and physical therapeutics until the muscle balance is sufficiently restored

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STANDARDIZED RESULTS OF WOUND HEALING*

BY CHARLES L. GIBSON, M.D.,
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SURGEON TO THE FIRST (CORVELL) SURGICAL DIVISION OF THE NEW YORK HOSPITAL

THIS study is an attempt to systematize the records of wound healing by the adoption of a standard which aims at a greater degree of accuracy than usually obtains. It also seeks the causes of imperfect wound healing and to correct such accidents.

Our studies have extended over a period of years and the methods we now employ represent the successive stages of what we believe is a more correct method of investigation. In our early attempts a graphic chart of the weekly results was kept, but later abandoned for a monthly record which more nearly eliminates the statistical fallacies.

The facts and figures which we now present are based on the monthly record from January 1, 1920, to July 1, 1921. They represent only a small portion of our clinical material, as it was thought wisest to stand or fall by a limited group of what might be called ideal cases, that is, presenting no conditions of possible infection from the disease itself. For this record, therefore, all such cases as acute appendicitis, any form of salpingitis, any wound that is drained, is not included in our computation. Originally we graded the operations on the stomach and duodenum, but have not included these in our more recent statistics, for it seemed unwise to include these cases which do not represent the same conditions as the bulk of material, more particularly on account of the impaired nutrition of the patients before operation and during convalescence.

Out of 2277 cases admitted to the First Surgical Division only 437 were classified as to wound healing. The main class of cases on which grades were given is as follows: All hernia except strangulated, cholelithiasis without drainage, bones (amputations, open reductions and bone grafts), benign tumors (fibroid uterus, cystoma of ovary, dermoid cyst of scalp), laparotomies for malposition of uterus, adhesions of peritoneum, chronic mastitis, varicose veins, chronic appendicitis, etc.

Manner of Tabulating Results—The material is divided into three groups. Grade I represents absolutely irreproachable wound healing, Grade II small disturbances of wound healing, such as small hæmatoma or trivial infection, but none of these accidents delaying wound healing beyond the usual normal period, Grade III all other cases, that is, all infections.

We feel it is particularly important to differentiate between hæmatomata, classified under Grade II, and infections, Grade III, as the Grade II mishaps

* Read before the American Surgical Association, June 15, 1921. Published paper contains figures up to July 1, 1921.

STANDARDIZED RESULTS OF WOUND HEALING

are more apt to represent individual errors while Grade III may well be laid to a faulty system

Manner of Giving Ratings—With rare exceptions the ratings are given by me personally. During my absence in the summer no accurate record has been kept of results. Ratings are made on weekly "Field Rounds." If wounds are definitely healed, say at the end of seven or eight days, the grade given is usually final. If the rating is given, say at four or five days, a note is given that the final result must be checked up and is so checked up by me the following week.

These notes are all given in the presence of the Staff at "Field Rounds," and if any possible dissension exists the grade is given according to the consensus of opinion. Occasions for such discussion, however, are almost unknown at present, which indicates that our present system is simple and efficient. At the end of the month results are tabulated as indicated on the charts (Figs 1 and 2).

In addition to the notes made at the weekly rounds, the results of wound healing are discussed at the weekly staff conference which follows weekly rounds. At this conference explanations for disturbances of wound healing are sought and given and decisions are taken which may influence subsequent procedures. Records are also kept of changes in the staff, both nurses and internes, and the dates of changes of procedures and technic are indicated.

Results—Out of 437 cases classified as to wound healing there were 39 (9 per cent) with disturbances of wound healing. These were divided as follows: Grade II, 25, or 6 per cent; Grade III, 14, or 3 per cent.

The following main classifications are given, showing results of wound healing.

Diagnosis	No. of cases recorded	Disturbances of wound healing	Grade II	Grade III
Inguinal hernia	172	14 (8 per cent)	8 (5 per cent)	6 (3 per cent)
Chronic appendix	90	6 (6 per cent)	4 (4 per cent)	2 (2 per cent)
Bone cases	25	4 (16 per cent)	4 (16 per cent)	0
Fibroid uterus	19	1 (5 per cent)	0	1 (5 per cent)
Malposition of uterus	14	1 (7 per cent)	1 (7 per cent)	0
Femoral hernia	13	1 (7 per cent)	0	1 (7 per cent)
Incisional hernia	12	2 (16 per cent)	1 (8 per cent)	1 (8 per cent)
Varicose veins	10	1 (10 per cent)	1 (10 per cent)	0
Adhesions	8	2 (25 per cent)	1 (12.5 per cent)	1 (12.5 per cent)

It will be noted that the main classes are of inguinal hernia and chronic appendicitis. We have long realized that in inguinal hernia we can expect a moderate number of disturbances notwithstanding our constant efforts to minimize them. Of late we have redoubled our energies as regards preliminary cleansing of the skin of these patients, and our latest technical improvement consists in suturing the aponeurosis to the external oblique with interrupted sutures instead of continuous, thereby lessening the danger of disturbance of the circulation and, in addition, turning in the knots of the sutures toward the deep surface of the wound.

An interesting point is in regard to the removal of the appendix in the course of operations for right inguinal hernia. It is our custom to do so when the appendix can be easily brought into view and its removal performed without possible trauma. The following tabulation is rather interesting in that it does not give support to the view that removal of the appendix is a possible source of contamination. This view, I am informed, was held in the army and at one period orders were issued forbidding this procedure †

TABULATION OF HERNIA OPERATIONS

Since January 1, 1917

	Per cent
666 hernia with 33 infections	4.95
506 hernia without appendectomies—26 infections	5.13
160 hernia with appendectomies—7 infections	4.37
203 right hernia without appendectomies—14 infections	6.89
303 left hernia—12 infections	3.96
363 right hernia—21 infections	5.78
One case of acute appendicitis with small abscess was removed through hernial wound. Primary union	
One case of abscess base of appendix opened above. Hernial wound healed by primary union	

Other Factors—A study also is being made of the results according to the nationality, age and sex of the patient. So far we do not feel justified in drawing any conclusions. We find that at present 80 per cent of our patients are foreign born, and it will be readily understood that, as these patients include many recent immigrants, standards of health, nutrition, and cleanliness must be somewhat lower than we would desire.

Preparation of the Skin—Since the fall of 1918 we have replaced tincture of iodine by picric acid 5 per cent alcoholic solution and continue to be well pleased with it. We believe our results justify our confidence in its antiseptic qualities and its use has been entirely free from the occasional irritation produced by tincture of iodine. Moreover, we have reason to believe that picric acid, if carried into the peritoneum, causes less damage than tincture of iodine ‡

In employing picric acid we have no hesitation in using "wet preparation" and the patients are scrubbed and shaved with soap lather. With the exception of hernia, no other form of antiseptic is used.

† Information furnished by Dr W. A. Downes

‡ "The Advantages of Picric Acid Over Tincture of Iodine for Disinfection of Skin," Charles L. Gibson, *ANNALS OF SURGERY*, February, 1919

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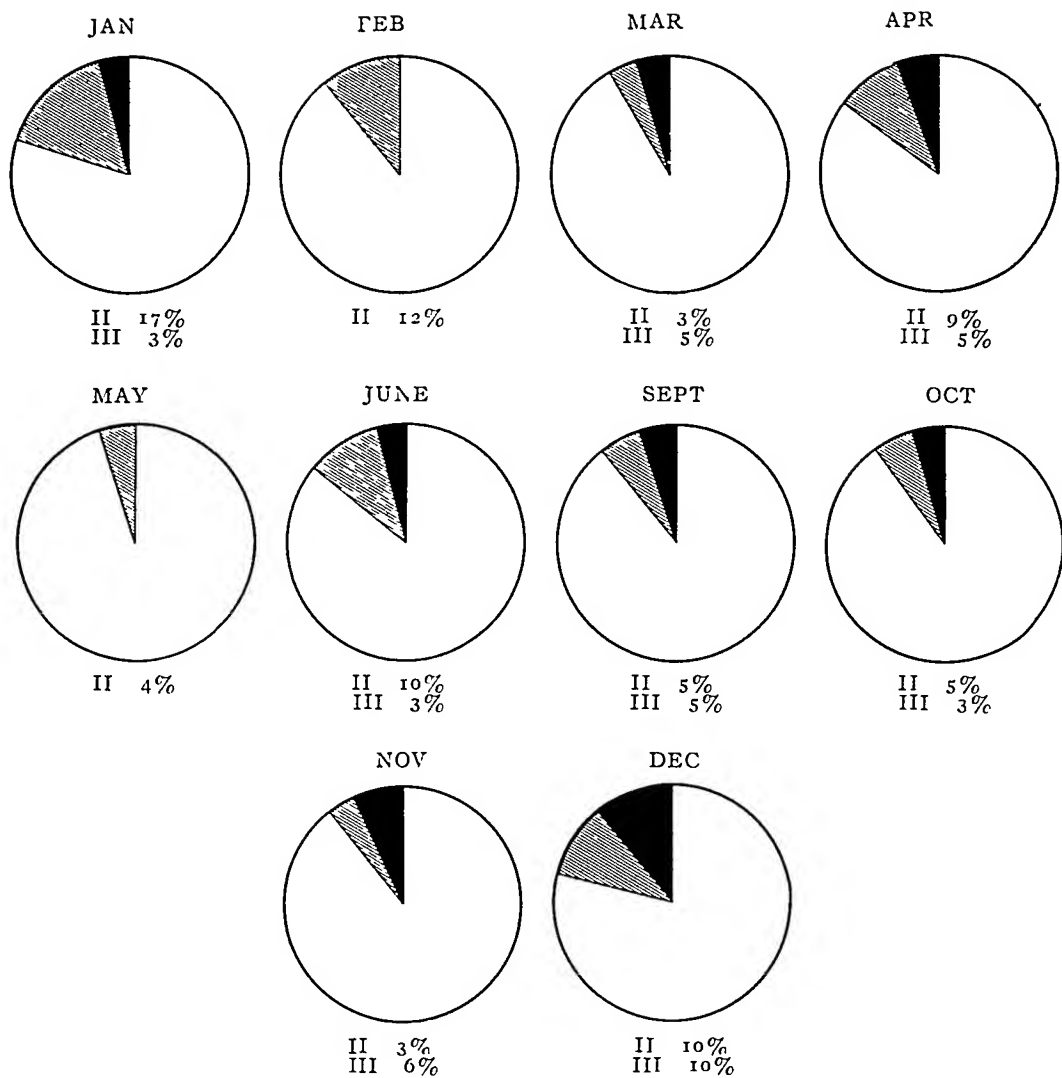


FIG 1 —Results of wound healing—1920 Class I (white) Ideal wound healing Class II (shaded) Slight Mishaps Fo detriment to wound healing Class III (black) All Infections

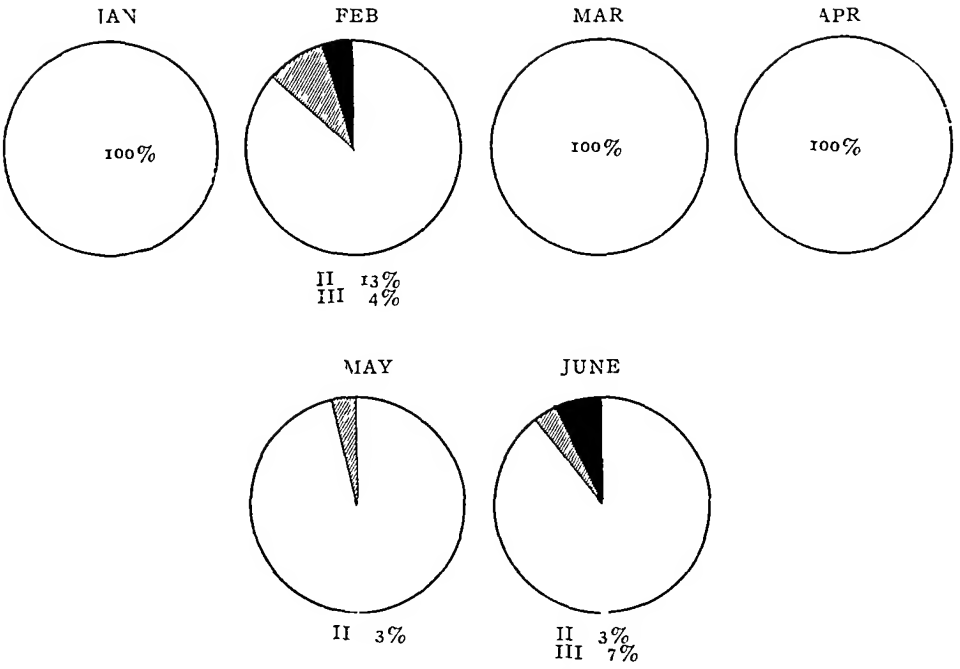


FIG 2 --Results of wound healing--1921

STANDARDIZED RESULTS OF WOUND HEALING

CONCLUSIONS

This paper is not intended to exploit our results and we wish again to insist that the operations here reported do not represent our total series but merely a limited group of cases which we believe is a fair index of our probable results. What we wish to emphasize is the great importance in a hospital service of carrying out systematically and continuously such an investigation. The psychical stimulus and interest are most pronounced and helpful.

THE SURGICAL REMOVAL OF PANCREATIC STONES*

BY WALTER ELLIS SISTRUNK, M D

OF ROCHESTER, MINNESOTA

PANCREATIC stones occur so infrequently that one is seldom called upon to remove them surgically. A review of the literature shows very few cases in which a pancreolithotomy has been performed. It is probable that such stones are often overlooked during the course of abdominal explorations, as they have been found at autopsy on a number of occasions. The consistency of the pancreas is probably responsible for the difficulty with which they are recognized at operation. When multiple stones are present a sense of crepitation is brought out upon palpating the gland, which makes the diagnosis easy, but single stones are difficult to recognize when palpated through the pancreatic tissue. In reviewing the histories of the patients operated upon for pancreatic calculi in the Mayo Clinic, I find that during eleven years this operation has been performed only four times. It is customary in this clinic to routinely examine the pancreas in all patients operated upon for upper abdominal disease, and the fact that so few pancreatic calculi have been found by surgeons who routinely examine the pancreas during this time shows that pancreatic calculi are either extremely rare or very difficult to recognize at operation. The presence of stones in the pancreas was first reported by Graaf in 1667, and the first report of the surgical removal of stones was probably that of Mr. Pierce Gould in 1896. Since then case reports have occasionally been published, but to the present time the list of reported cases is extremely small.

Pancreatic calculi very closely resemble the calculi found in the ducts of the salivary glands. They are usually of white or slightly gray color, fairly firm in consistency, brittle and irregular in shape, however, they may be faceted on a portion of their surface, as was seen in the stones removed from one of our patients. Chemical analyses which have been made have shown that they are composed of carbon salts, phosphorus or magnesium salts and organic matter.

As there is still considerable controversy as to the etiology of pancreatic diseases it is impossible to say just how these stones are formed and what part they might play as a factor in pancreatic disease. It would seem, however, that the manner of their formation must be very similar to that of stones in the biliary tract, that is, from infection in the ducts or from the stagnation of pancreatic fluids from obstruction.

* Read before the American Surgical Association, June 15, 1921

SURGICAL REMOVAL OF PANCREATIC STONES

Diabetes has often been observed associated with pancreatic stone. Hansemann in seventy-two cases of diabetes associated with pancreatic disturbances found stones in twelve cases, and Oser in seventy cases of lithiasis observed that diabetes was recorded twenty-four times. It is difficult to say just what part, if any, these stones played in the production of the diabetes. It seems most likely that both the diabetes and the stones had resulted from the chronic inflammatory changes in the pancreas but it is possible that the diabetes may have resulted from the chronic inflammatory changes in the gland produced by the calculi.

Pancreatic calculi have been reported in some instances where pancreatic cysts were present and it is probable that they are responsible for the formation of certain of these cysts.

The symptoms produced by stones in the pancreas are so very similar to those seen in chronic pancreatitis associated with stones in the biliary tract that a definite diagnosis of their presence in the pancreatic ducts is impossible. The presence of stone may be suspected and several cases have been reported in which such a diagnosis was made and was later confirmed at operation, but a definite diagnosis can be made only at operation. On account of this difficulty in diagnosis, the pancreas, during the course of operations for infection or stones in the biliary tract, should be carefully palpated for evidences of stone.

Pancreatic calculi may be single or multiple or may entirely fill both of the pancreatic ducts. They also have been found near the periphery of the gland, where they have formed in the small ducts. When they are located in the ducts near the point where these empty into the duodenum they may often be recognized at operation by careful palpation, when multiple stones are present they may be recognized by the peculiar feeling of crepitation which they impart to the palpating hand upon manipulation of the gland. It is difficult to decide definitely as to the character of localized tumors in the head of the pancreas, as these may be due either to neoplasms or to impacted stones surrounded by an area of inflammation. In one of the cases operated on here, as in a case reported by Link, a distinct ridge was present on the anterior surface of the gland which corresponded to the course of Wirsung's duct, which could be felt throughout the entire length of the pancreas.

Up to the present time very few operations have been performed upon the pancreas proper, and in most instances the chronic inflammatory diseases of this gland have been treated indirectly by drainage of the gall-bladder or common duct. Experimental work done by Opie, Coffey, Sweet and others tends to show that surgery of the pancreas is not necessarily attended with the risk commonly supposed to be present. Operations for the removal of

pancreatic stones present no unusual difficulties except in instances where the stones are impacted in the ducts near the ampulla, and, I believe, can usually be performed safely. When operating for stones the pancreas should be exposed by the route which seems to offer the best exposure of the gland. If the stomach is high, exposure can be best obtained through the gastrocolic omentum, while if the stomach is low, it can best be exposed through an opening in the gastrohepatic omentum. The pancreas also has been exposed by lifting up the omentum and colon and making an incision through the transverse mesocolon. Stones have been removed from the lower portion of the duct of Wirsung through an incision through the mesentery of the duodenum, and cases have been reported in which the anterior wall of the duodenum has been opened and stones removed by incising the papillæ of Vater and the posterior wall of the duodenum, thus exposing the ampulla and the end of the pancreatic duct. Following the removal of calculi, hemorrhage may be easily controlled and the opening in the duct closed without difficulty with small silk sutures. In the case reported by Link the tail of the pancreas was drawn out through an opening made in the transverse mesocolon, and after the stones had been removed a catheter was used to drain the pancreas, the tail of which was drawn out through the abdominal incision.

The ducts of the pancreas are without valves, and in cases of obstruction where pancreatic drainage is thought advisable it is possible that an operation of the type described by Link or that described by Coffey, in which the cut-off end of the pancreas is transplanted into the jejunum, might be done. In the four cases operated on in the Mayo Clinic the openings in the pancreatic duct were closed and rubber tissue drains used to take care of any pancreatic fluids which might escape. The experimental work of Opie, which has been confirmed by Coffey and others, has shown that fat necrosis occurs only when pancreatic fluid is poured into and confined in the retroperitoneal fat, when pancreatic fluid is delivered inside the unbroken peritoneum, fat necrosis does not occur, and no harm can result from this provided sufficient drainage is placed to readily conduct the pancreatic fluid to the surface. It would seem safest, therefore, in operations where the pancreatic ducts are opened, that some provision be made for carrying off the pancreatic fluid in case leakage should occur.

I wish to report in this paper four cases operated on in the Mayo Clinic since 1910.

CASE I—Female, aged forty-eight years. For fourteen years the patient had attacks of sudden, sharp, cramp-like pains in epigastrium, radiating through to the back, accompanied by nausea and often by deep jaundice, for many years a good deal of flatus and diarrhœa, often having as many as twenty-five stools, without blood or mucus, in twenty-four hours. Jaundice for one year. Considerable weight and

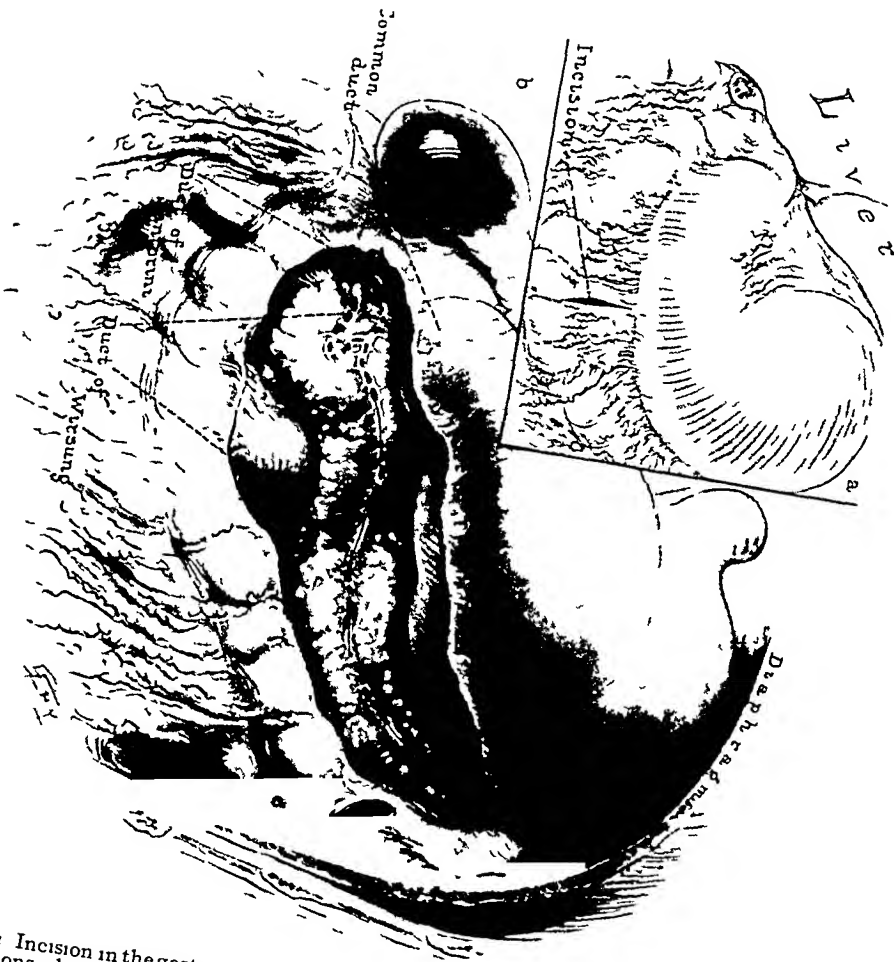


FIG 1 —a Incision in the gastroduodenal omentum b Opening in the lesser peritoneal cavity and incisions along the course of the pancreatic duct The gastroduodenal omentum has been divided extensively in order to show the entire pancreas



FIG 2 —The mesentery of the duodenum is incised and the duodenum turned back in order to expose the head of the pancreas

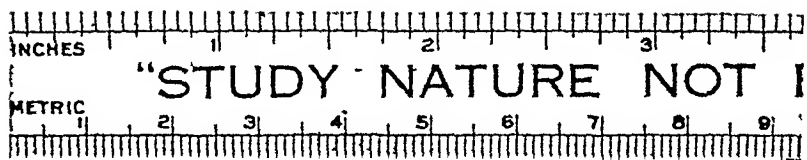


FIG 3 —(Case A288735) Pancreatic stones

SURGICAL REMOVAL OF PANCREATIC STONES

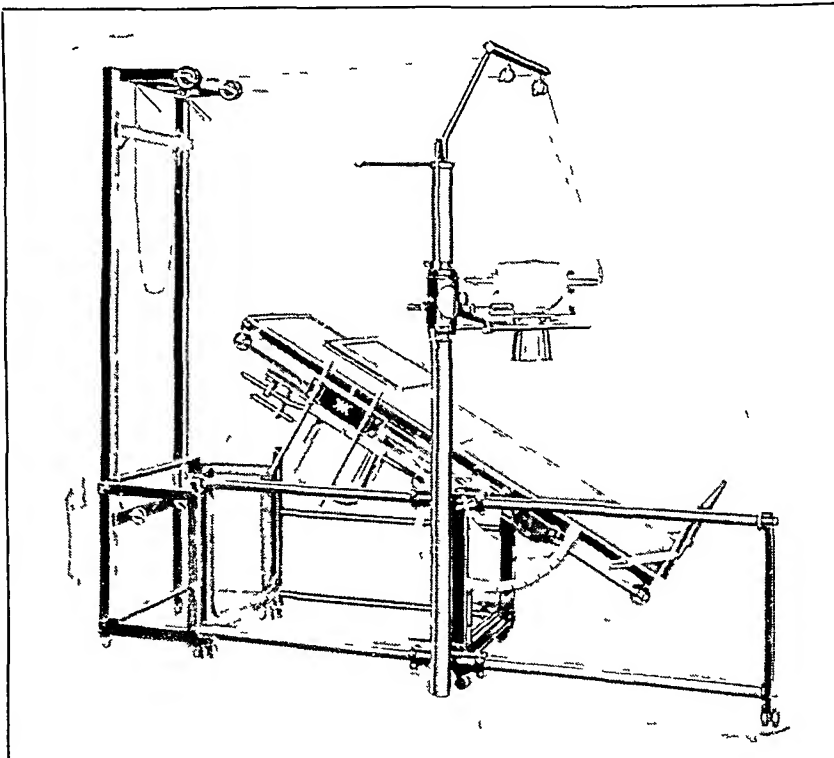
strength loss A diagnosis of gall-bladder disease with probable common duct stones was made Operation June 16, 1910 A stone the size of a filbert and several smaller ones removed through an incision in the anterior wall of the duodenum, this stone found in a diverticulum in the head of the pancreas just off from the common duct at a point about one-half inch above the papilla Ampulla opened for distance of about one-half to three-fourths of an inch Gall-bladder largely destroyed, remnants of it removed Spleen four times normal size Patient also had pyloric obstruction from chronic duodenal ulcer and at another operation a gastroenterostomy was made Two years later she was in excellent health

CASE II—Male, aged thirty-three years History typical of gall-stones for several years One year previously operated upon elsewhere with removal of stones from gall-bladder and common duct, drainage of gall-bladder Pancreas found to be enlarged and thought to contain stones, but no attempt to remove them When examined in Mayo Clinic patient found to have diabetes, sugar disappeared from urine under treatment and strict diet Operation October 1, 1919 Enlarged gall-bladder which was free from stones Two stones removed from common duct Pancreas slightly enlarged and quite hard Peculiar crepitating feel imparted to hand upon palpating pancreas, and a ridge could be felt on anterior surface of the gland corresponding to the course of the duct of Wirsung, which extended from the tail to the head Pancreas exposed through opening in gastrocolic omentum and many stones removed through four incisions in the duct of Wirsung Several stones in the duct near the ampulla removed through an opening made through mesentery of duodenum Openings in the duct closed with small silk sutures Gall-bladder and common duct drained Several rubber tissue drains Duct of Santorini seemed filled with stones, but on account of extent of operation already performed no effort made to remove these stones Diabetic condition improved considerably after operation and sugar tolerance became much increased Lately patient has had symptoms indicating that infection is still present in biliary tract

CASE III—Female, aged sixty-eight years Attacks of epigastric pain radiating to left side but not to the back for some years Fifteen pounds weight loss within past year Appendix found to be definitely diseased Multiple stones could be palpated in head of pancreas These removed through opening made through mesentery of duodenum Stones appeared to be in main duct of pancreas but were near surface Uneventful recovery No subsequent notes

CASE IV—Female, aged sixty-two years History of ulcer of duodenum for fifteen years X-ray showed pyloric obstruction Unable to obtain history of gall-bladder trouble Operation January 1,

1921 Chronic perforating duodenal ulcer with pyloric obstruction found A stone could be felt by palpation in pancreatic duct near ampulla Opening made in duct through mesentery of duodenum and two stones size of navy beans removed Gastroenterostomy made Good recovery No subsequent notes



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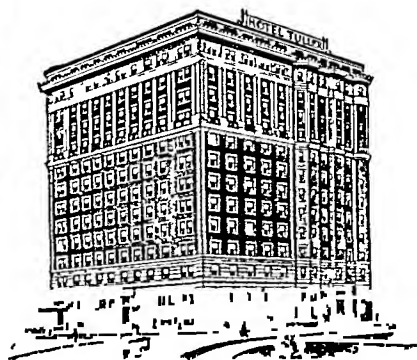
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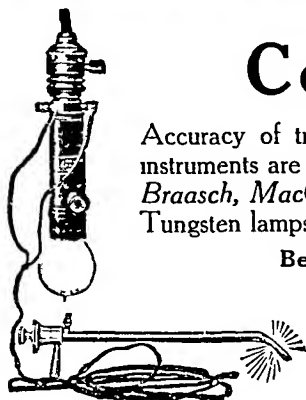
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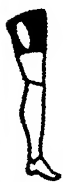
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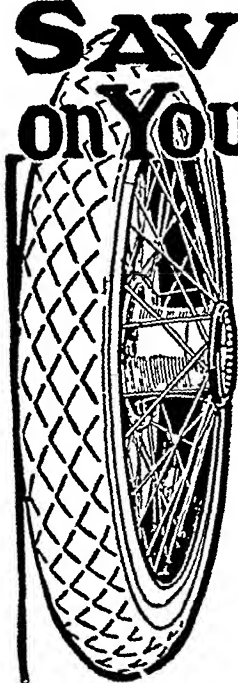


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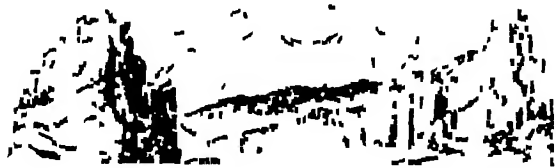
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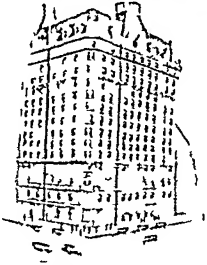
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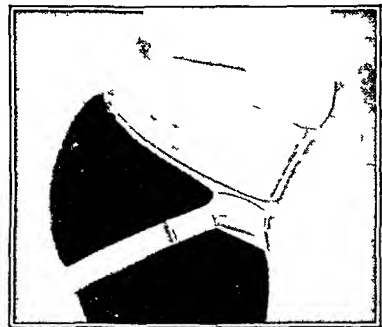
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With the Collaboration of

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WITH THE COLLABORATION OF

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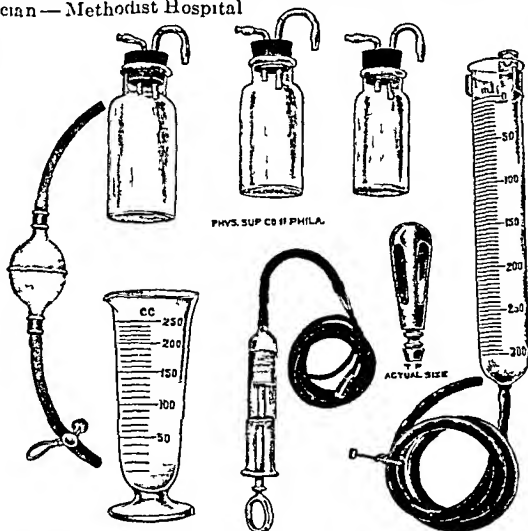
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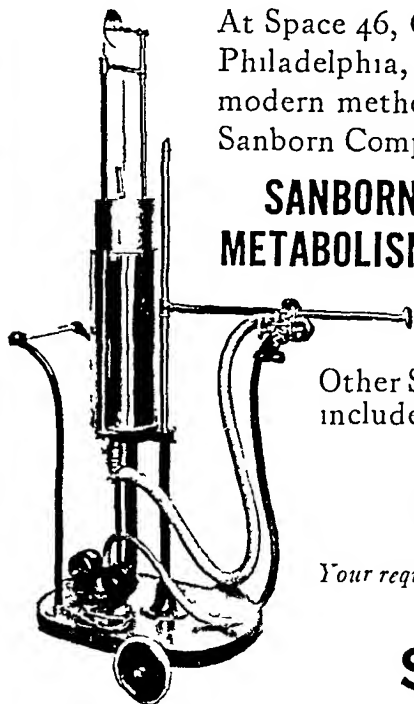
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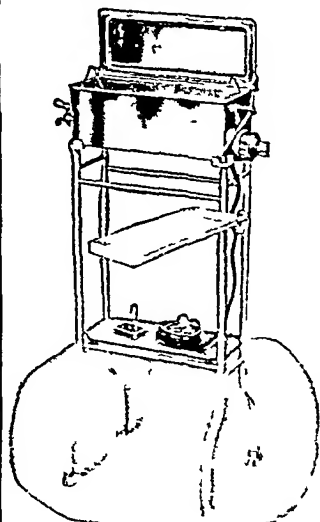
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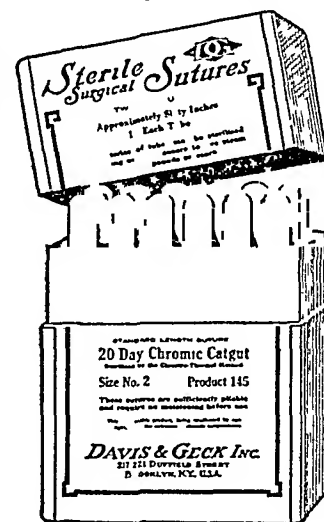
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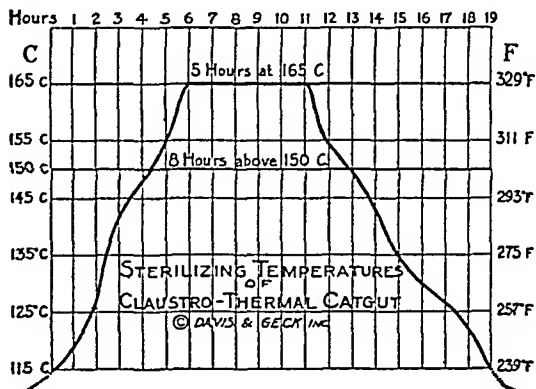
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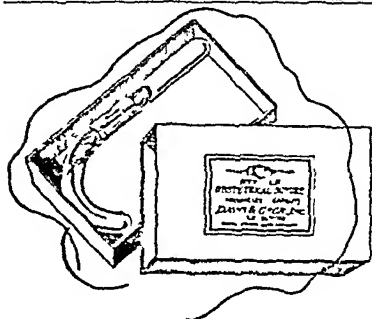
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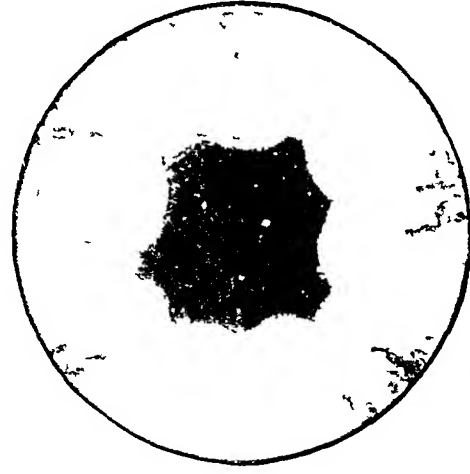
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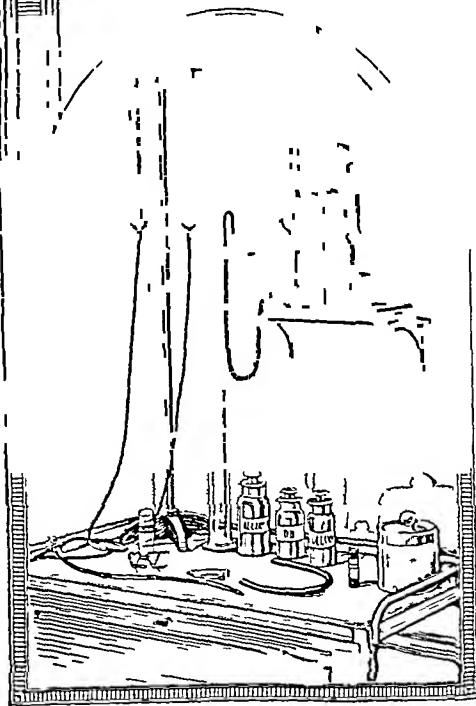
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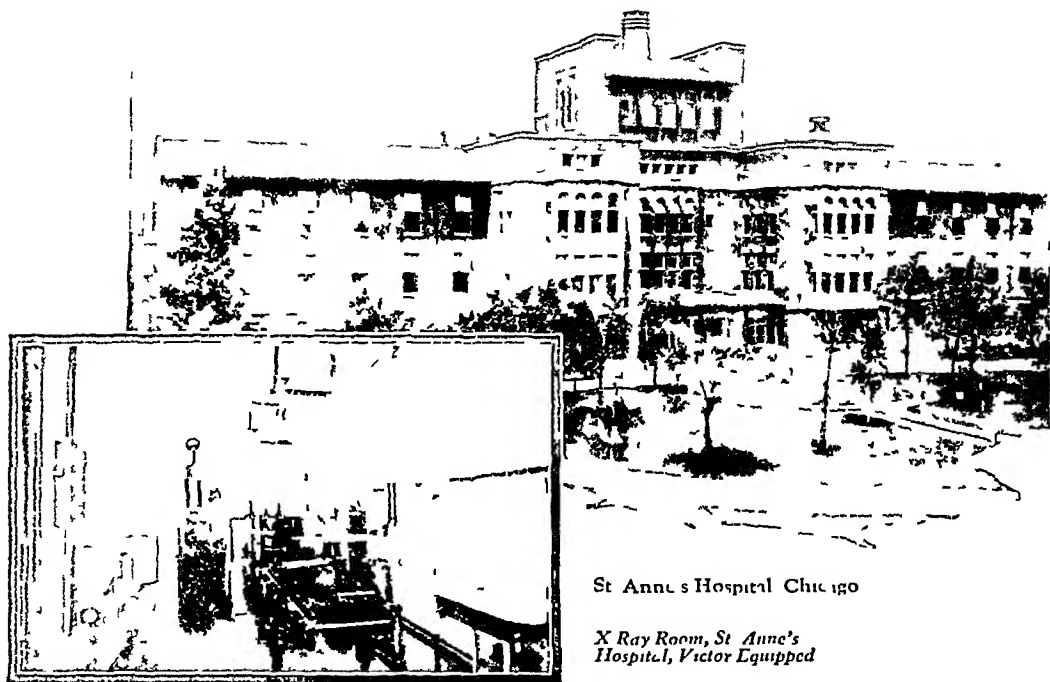
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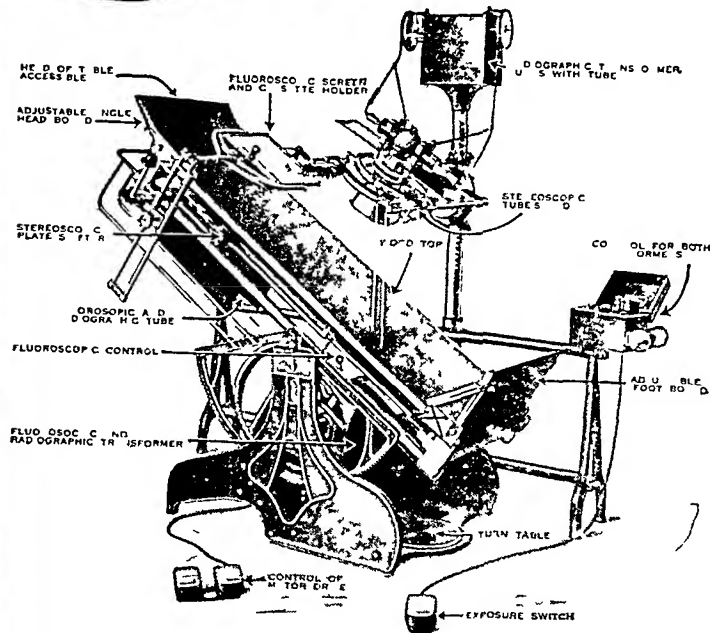
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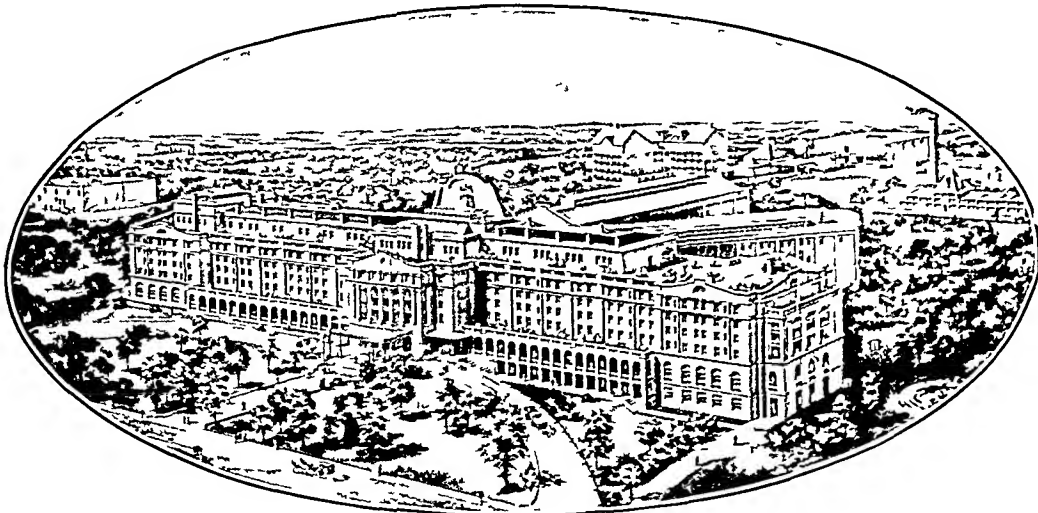
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SOME RESEARCHES ON THE PERI-ARTERIAL SYMPATHETICS*

BY RENE LERICHE, M.D
OF LYONS, FRANCE

THE sympathetic nervous plexuses included in the external layer of blood-vessels seem to possess a real autonomy. The systematic study of the phenomena which follow the exciting of average-sized arteries, that is, of prevailing muscular structure, reveals the existence of a very characteristic physiological reaction which never fails in normal circumstances.

A knowledge of the constituents of this reaction is quite interesting from the triple point of view of physiology, pathology and therapeutics, it sets new problems in physiology, it permits us to explain certain pathological phenomena, finally, it authorizes some promising therapeutic attempts.

I feel the best way I can express my thanks for the great honor the American Surgical Association has done me in inviting me to take part in their work is to present to it the results of my researches on this subject, these last few years.

I. When you remove the sheath of an artery, the brachial artery for instance, you see, just at the moment its external layer is pinched, the vessel contracts, its pulsation stops at once and its size diminishes. If you excise the cellular layer the diminution will progressively reach the third or the fourth of the normal size of the artery. The segments on both sides maintain their normal size provided the operation has not injured them.

This arterial contraction usually causes the pulse to disappear, but it does not altogether interrupt the circulation.

If the artery is cut a thin thread of blood is seen inside, on the other hand, if during the experiment capillaries are examined by Weiss's method, you will see, at the moment the arterial contraction takes place, the capillary loop diminish regularly in its whole length, pale but remaining visible. If the artery is tied the loop is almost indistinguishable, though a little blood still passes (Fig 1).

The arterial contraction is the primary element of the characteristic physiological reaction against excitation (Fig 2).

SECONDARY SIGNS.—In the following hours pulsation is imperceptible or very feeble, the operated limb is colder than the other, there is a difference

* Read before the American Surgical Association, June 15, 1921.

of 3° or 4° C After several hours, varying from three to fifteen, secondary signs appear which form the next element of the characteristic reaction

They never fail when the excision of the nervous layer is really performed, if they are wanting, it is due to the incompleteness of the nerve operation Out of sixty-four operations only one failed, in this case, one of my first, the artery was enclosed in fibrous tissue and did not contract during dissection, thus I had not touched its nervous sheath The secondary signs are the following

1 An elevation of local temperature reaching 2° and even 3° C, central temperature not being modified The patient has a subjective sensation of heat One of my patients complained the day after operation of "a hell fire" in his hand

2 An elevation of the arterial pressure, which may reach 4 c c of mercury *according* to the healthy side Claude Bernard had already noted the same figures when measuring arterial pressure after section of the sympathicus in the neck

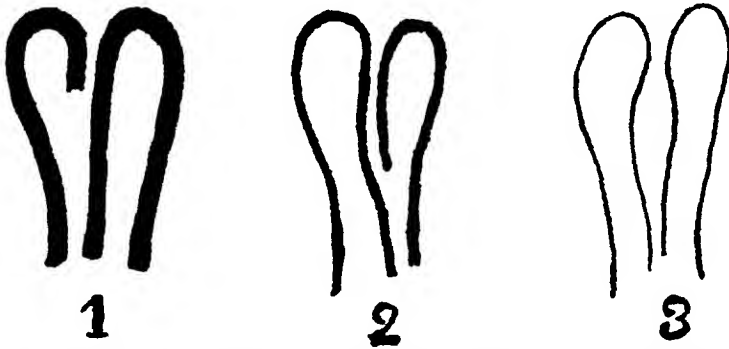


FIG 1—(1) Aspect of a normal capillary loop in a finger examined by Weiss method, (2) diminution of size when the brachial peri arterial nerve is excited (3) almost complete disappearance after ligature of the brachial artery

3 An increasing amplitude of oscillations, shown by the sphygmomanometer

These statements have been verified on my patients by my friend, Doctor Heitz, one of the most eminent cardiologists of France

The vasodilator reaction is transitory, after peri-arterial sympathectomy it becomes attenuated from the fifth to the sixth day and disappears after three or four weeks

Such is the characteristic physiological syndrome of the peri-arterial sympathetics against excitation

II Pathologically, this excitation may be provoked as well on visceral arteries as on arteries of limbs, and this by direct traumatic causes or indirect infectious or toxic causes

Whatever may be the cause, as soon as the peri-arterial sympathetic plexus is injured the physiological reaction appears, in exactly the same way the oculopupillar reaction follows the injury of the cervical sympathetic plexus

THE PERI-ARTERIAL SYMPATHETICS

At the level of the viscera we know absolutely nothing of these reactions, we may suppose that ischæmia and prolonged vasodilatation with consecutive elevated blood-pressure may disturb the ductless glands for instance, the thyroid or pancreas, but we have no positive experience concerning the subject. The only experimental fact I know is the following. In a case of diffuse œdematous thyroid hypertrophy a unilateral high perithyroidal sympathectomy caused an extreme diminution of size of the corresponding lobe in the next few days. That is a little thing but it allows one to believe there is a very interesting field of future research.

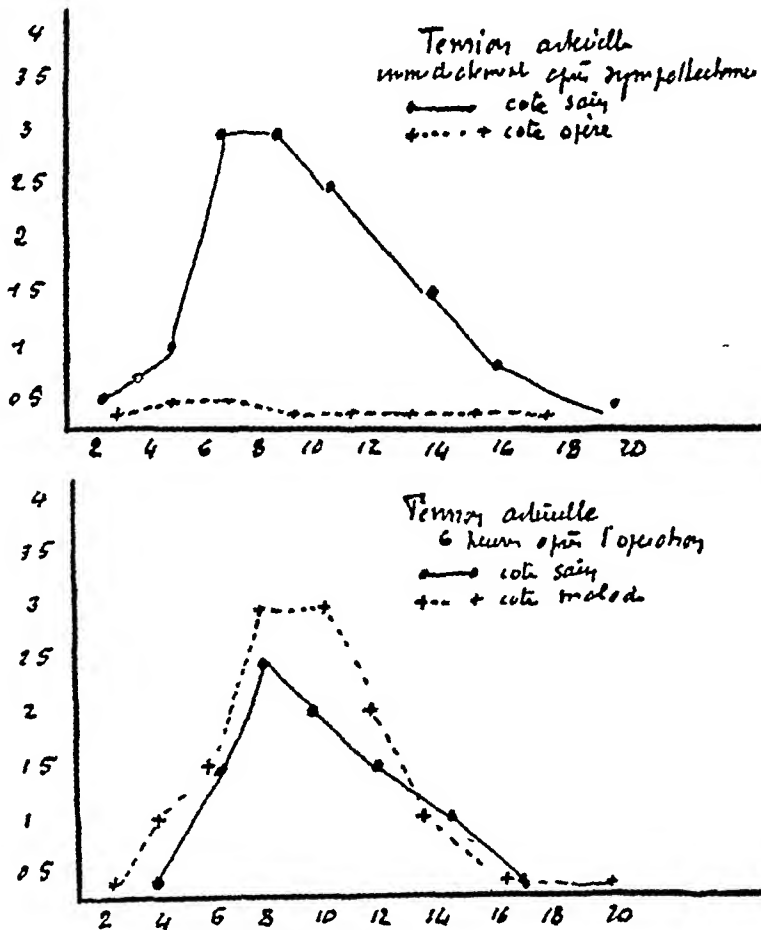


FIG 2 —(1) Sudden lowering of the arterial pressure immediately after excitation of the peri-arterial sympathetic, (2) rise of the arterial pressure following the preceding phases

Finally it is only at the level of limbs that we begin to distinguish the phenomena resulting from an injury of the peri-arterial sympathetic plexus, and their analysis is not easy.

To expose them as clearly as possible one may isolate two groups. In the first group the characteristic physiological reaction is pure, with two striking aspects, in the second case, reaction is disturbed and gives various troubles.

First Type. One may choose two characteristic examples, "stupeur des artères" and Raynaud's disease. I will not insist on the well-known syndrome of "stupeur artérielle". It is an active secondary spasm due to sud-

den excitation of the external arterial layer, a woundless traumatism may produce it as well as a projectile. We have noticed it after violent shock of the humerus, the arm being limp and lifeless, the fingers colorless, one might have thought the brachial artery was crushed. There was really no injury and these phenomena were temporary.

Against Kuttner's opinion I still believe that this contraction is of nervous origin instead of muscular origin, and this for reasons I do not want to develop here.

I want only to make you notice that, in certain cases, the contracture may be so intense as to lead to gangrene from insufficient circulation. This led during the war to unnecessary amputations.

Raynaud's symptoms are typical of vasomotor sympathetic disease. In certain cases of the peri-arterial sympathetics of the whole limb seem to be excited, for the vascular contraction involves even the capillaries, producing deformations that may be seen on the living limb.

This may be observed surgically when the sympathetical irritation is manifest, for instance, in the case of cervical rib or in certain subclavian obliterations (Fig 4). In these cases the crisis has the exact figure of the physiological reaction with its two characteristic phases, painful ischæmia and consecutive vasodilatation.

Second Type In many circumstances the initial cause is less known and the physiological reaction is disturbed, either by contracture of too long duration or by abnormally persisting dilatation.

In all cases it produces considerable biological disturbances in the subjacent tissues, creating thus various associations of motor, sensitive, vasomotor, glandular and trophic symptoms, or even signs of local necrosis.

Concerning sensibility there may be no systematized hypoæsthesia, but principally painful causalgic phenomena. These troubles are not provoked by an injury of sensitive nerves but begin at the level of the tactile apparatus. The Meissner's, Pacini's and Ruffini's corpuscles are surrounded by a rich vascular network, insuring the perfection of sensations.

Supposing the vascularization disturbed by inflammation, the nervous apparatus suffers at first contact. The sympathetic injury producing peripheral vasodilatation has the identical effects: thus may be explained the acute pains in Weir Mitchell's causalgia and certain painful stumps.

By a less-known process, injury of the peri-arterial sympathetics may provoke motor troubles, either stiffness and contracture, a kind of hypertony localized to certain muscular groups, or a rapid atrophy.

One has noted in "*stupeur arterielle*" immediate muscular rigidity. The same contracture was also frequently noticed after war wounds and described under the name of reflex troubles by Babinski and Froment.

In these cases when acting on the peri-arterial sympathetics one has seen motor troubles diminish or even disappear as if the contraction of stripped muscles were dependent on the sympathicus (Fig 6).

One may believe muscular symptoms to be but consequences of defective circulation and that sympathectomy acted in modifying it, but one must not forget that the histologists admit for the muscles both a myelinic and amyelinic innervation. The influence of the sympathetics on the muscular

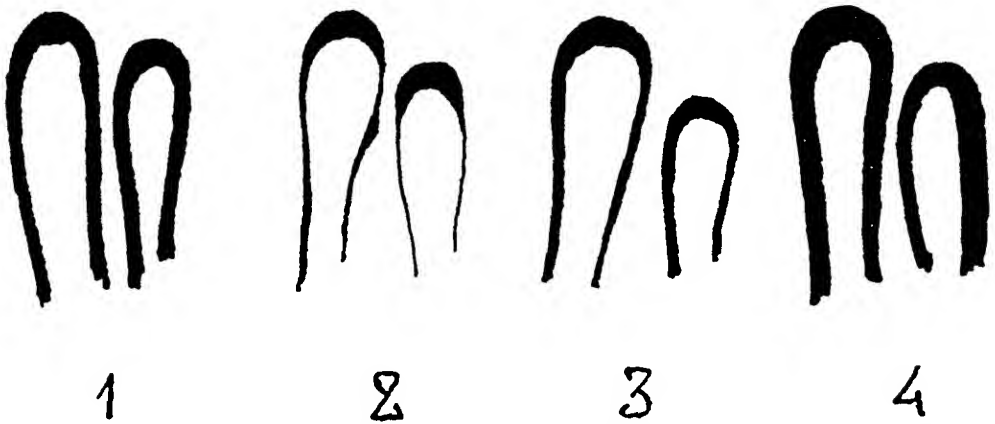
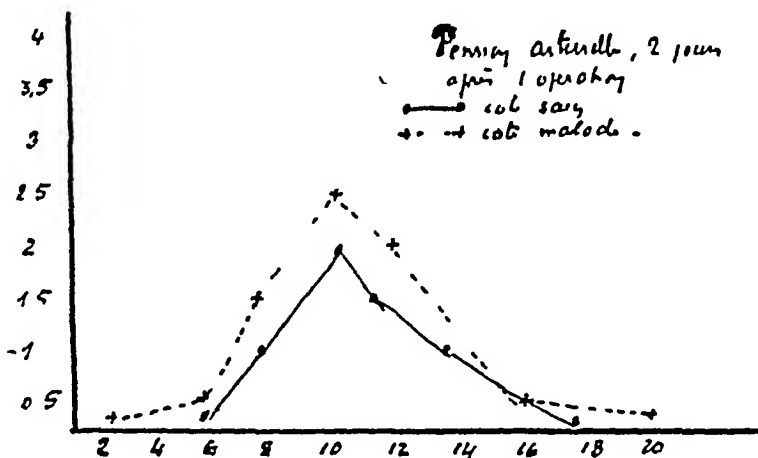


FIG 3 — Figures showing the capillary loaf in a finger and its different sizes before and after Raynaud's disease (1) Normal, (2 and 3) contracture irreguliere (4) surdilatation après la cure

tonus was shown by De Boer, and the modern neurologists seem to believe that the tonus of muscles at rest is conditioned in invertebrates by the sympathetic system. The presence of motor phenomena is thus easily explained.

In association one frequently notices changes in the sudorific function, profuse sweating or absolute dryness of the skin, which form a constant symptom of the peripheric feature. As in causalgia, one frequently sees



trophic troubles concerning nails, hair or skin and even spontaneous blisters

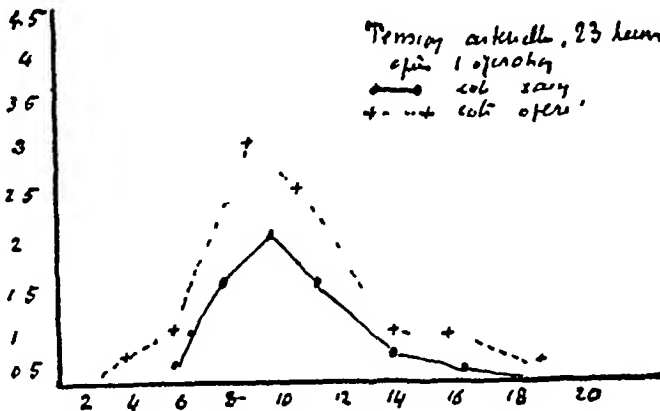
Sometimes repeated pressure produces sloughs on limbs whose sympathetic functions are disturbed by a traumatism or amputation

Other vasomotor phenomena are cyanosis, local blue œdema or large white œdema reaching the origin of the limb without any signs of phlebitis or arterial obliteration. Pains and muscular atrophy may accompany these

symptoms as well after deep contusions of the tip of the limb as in small traumatism

All these apparently different symptoms have one common point they are but the manifestation of a circulatory change, vessels being not injured, none of the apparatus concerning them is touched, nor the sensory, the muscular systems, or glands or skin And as all are more or less connected, there is evidently a common origin

This may not be found in the cerebrospinal nervous system as there is no systematized topography It is neither in the vascular apparatus which is anatomically healthy, operations on the vasomotor system seem to prove that their origin is to be found in the sympathetic innervation In some cases



there is anatomopathological proof The artery holds more than usually to the common sheath of the vessels by sclerous adhesions, and the external layer of the artery is more vascularized The artery presents a particular aspect, being striped in a parallel way by very fine vessels I have found these lesions with paroxysmal pains in chronic arteritis, in painful stumps and in trophic troubles But one must acknowledge that in most cases one cannot find any anatomical change explaining the vasomotor ataxy, for our knowledge on the anatomopathological features is still very imperfect

Another explanation of the syndrome might be given Sometimes when there is a defective vasomotor innervation the causal injury (bruise, fracture, scar) is often distant from the vessels, at the periphery, in a richly furnished zone of sensitive innervation and the vasomotor disturbances seem due to an ortho- or antidromic reflex, starting from the injured point, the way back being the peri-arterial sympathetics

This is explained by the fact that at the beginning of the accidents the sympathetic irritation may be sufficiently intense to bring forth spasm and fatal ischæmia in limited parts of the tissues Thus are produced the local gangrene of Raynaud's disease or after certain prolonged pressure Volkmann's syndrome symptomatic of local muscular necrosis

THE PERI-ARTERIAL SYMPATHETICS

Is it not the proof that modified circulation is the real cause of all the phenomena studied above?

III This leads one to believe that logically the treatment of those vasomotor or trophic troubles must aim to modify peripheric circulation by peri-arterial sympathectomy. The technic is to isolate the artery on 8 to 10 cm., to fix the vascular sheath after dividing, to hold one part with a forceps and dissect off the cellular tissue either with knife or cannular sound until there has been effected complete denudation of the vessel, which becomes greatly reduced in size. This brings no injury to the arterial wall. I verified this fact twice at four and eight months' interval.

I have performed this operation sixty-four times. In eleven cases of causalgia or equivalent syndromes, two cases of painful stumps, nineteen cases of post-traumatic contractures, four cases of large post-traumatic œdemas, one case of trophœdema, four cases of ischæmic sequels, one case of trophic sloughs on a stump, ten cases of trophic sloughs after nervous section, one case of trophic slough of the heel after medullary injury, one case of varicose eczema, one case of trophic troubles after frostbite, one case of spasmodic paralysis, three cases of an attempt to modify tension of cerebrospinal fluid, two cases of Jackson's epilepsy, one case of goiter, one case of intermittent claudication, one case of erythromelalgia.

I obtained remarkable successes and had complete failures. Operation failed in the case of intermittent claudication, in one case of trophic troubles after frostbite, in one case of spasmodic paralysis, and in certain cases of painful syndromes like erythromelalgia.

These failures are easily explained by the fact that the syndrome's nature is still unknown. Sympathectomy was performed, but as an attempt after numerous therapeutical trials. These failures, however, must not discourage, because their analysis may permit one to class in different groups seemingly alike facts and to enlighten some syndromes still obscure. This discussion shows the impossibility of delimiting yet exactly the indications of sympathectomy. I only want to give the results of five years' personal experience.

1 *In painful phenomena* sympathectomy is often very efficacious. In causalgia after war wounds it gave me in nine cases two complete failures, two satisfying improvements, and five excellent results, two of them being noted for several years. Platon has published a series of twelve cases, all seen again after more or less long intervals. He obtained 75 per cent of successes. In certain painful crises preceding gangrene caused by obliterant endarteritis with or without intermittent claudication it has given the same good results as in painful acroparæsthetic syndromes consecutive to bruise of finger, to wounds of hand, palm or footsole. Sympathectomy is thus worth trying in these cases.

It was twice performed for Raynaud's disease and gave a good result.

The result was less constant in painful stumps where I had one success and one failure. It seems to be efficient where the neuralgia of the stump

is associated with vasomotor crises, muscular contracture or convulsive cramps. The neurologist, Clovis Vincent, related recently a striking example. In a case of painful stump, both deep general narcosis and the section of the main nerves failed to attenuate the stiffness and the convulsive cramp. Immediately after sympathectomy the muscles relaxed, and forty days after the pains had not reappeared.

2 *Concerning muscular phenomena* only the hypertonic symptom is influenced by sympathectomy. Heitz and myself have seen it in contractions consecutive to war wounds. All eighteen patients were much improved, the day after operation contracture ceased and voluntary movements became possible. In some very serious cases, only sympathectomy permitted the motor reeducation. I do not believe one can improve by sympathectomy what is wrongly called Volkmann's ischæmic paralysis. Whatever may be its starting-point, the syndrome is the consequence of a muscle's focal necrosis, it is a definitive lesion that nothing can modify.

In three personal cases of trophœdema a rapid diminution of the œdema was obtained.

3 *In trophic troubles* leading to ulcers, sympathectomy is very efficacious: twelve cases out of thirteen were followed by rapid healing, but relapse is possible if the cause of the trophic trouble has not been removed, and the cause is not always removed by the sympathectomy.

This is the case in perforating ulcers which never were operated successfully. Therefore after my experience I should not advise it. Sympathectomy also failed in a case of numerous ulcerations consecutive to frostbite. The initial lesions, neuritis or arteritis, provoked relapse of the ulcers.

4 In cases of trophic symptoms after nerve sections results were excellent. In ten patients I obtained rapid healing of the ulcers by sympathectomy. However, after observing seventeen cases, I believe sympathectomy should be replaced here by the removal of the neuroma of the sectioned nerve, which is the starting-point of vasomotor reflexes causing the trophic trouble. The removal of the neuroma must be followed by the reconstitution of the nerve's continuity either by suture or by grafts, avoiding thus the relapse of the neuroma. I performed seven grafts with complete satisfaction and now prefer this method to sympathectomy in spite of its satisfactory results.

What is the real action of sympathectomy? How does it realize healing of the most desperate ulcers? This seems to me due only to local circulatory hyperactivity noted always after sympathectomy in the following hours, vasodilatation being apparently one of the most active causes in the tissue's growth, certain local giantisms observed during growth depend probably on constant vasodilatation. After sympathectomy, vasodilatation accompanies local elevation of temperature and of pressure, both favoring healing. This fact is experimentally proved in the following way. Having produced vasodilatation in a rabbit's ear by removal of the superior cervical ganglion, one makes on both ears a wound of equal size. The sympathetized side is

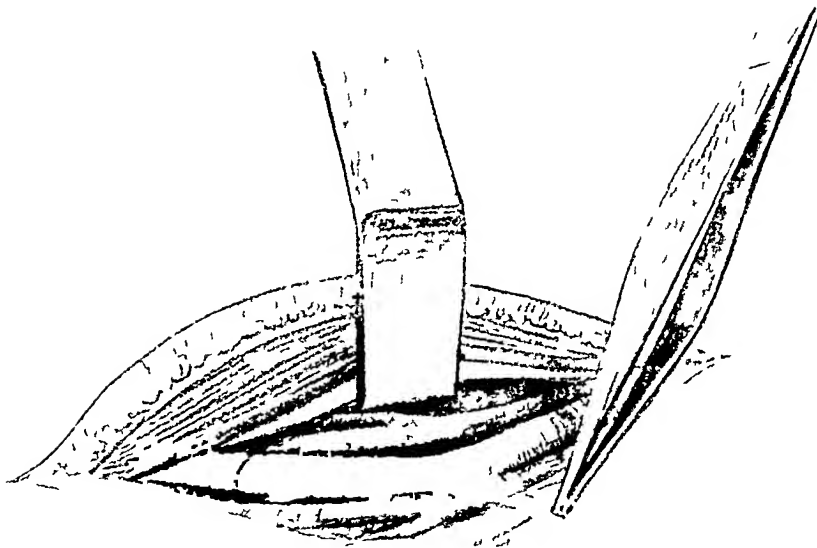


FIG 4 —The forceps catches a fold of the arterial external layer and holds it out of the wound
(1) In both figures the thickness of the external layer has been exaggerated to elucidate the demonstration Drawings by Dr P Bonnet, associate professor of surgery in Lyons

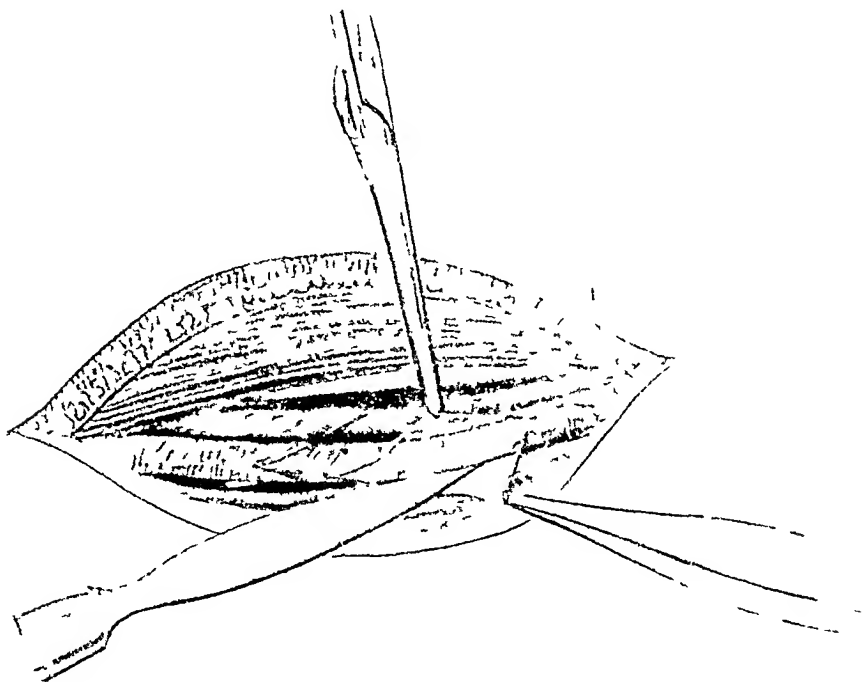


FIG 5 —The knife opens this fold and softly deco-ticates the artery



FIG 6 A —Contracture of the fingers after injury of the forearm



FIG 6 B —Contracture of the fingers after injury of the forearm—periarterial sympathectomy Result after three days



FIG 7 —Contracture of the fingers after injury of the forearm—peri arterial sympathectomy. Result after six days



FIG 8 A—Trophic ulcer of the first toe after section of the sciatic nerve



FIG 8 B—Trophic ulcer of the first toe after section of the sciatic nerve
Recovery eight days after peri arterial sympathectomy



FIG 9 A —Spontaneous ulcer of stump with vasomotor troubles



FIG 9 B —Spontaneous ulcer of stump with vasomotor troubles Healed by
peri arterial sympathectomy

THE PERI-ARTERIAL SYMPATHETICS

more abundantly bleeding and more intensively red colored. Four days later its wound is covered with granulations, epidermis begins to grow, while on the opposite side the wound remains gray-colored without any epidermic border. On the eighth day there is complete healing on the sympathectomized side, while on the other side healing extends only over half the wound. A fortnight later the scar of the vasodilated side is more regular and supple, of better quality than the other and shows no retraction.

Peri-arterial sympathectomy has identical effects. Healing of trophic troubles is thus a question of vasodilatation, and therefore peri-arterial sympathectomy must be tried in these cases. The characteristic of sympathectomy is to be more vascular than a nerve operation. For this reason its consecutive vascular reactions might perhaps be employed in many circumstances. Producing an immediate ischæmia, lasting eight or ten hours, one can perform it to insure preventive hæmostasis. I did it successfully in three brain operations. On the other hand, the post-operative vasodilatation being lasting, it could be utilized to help the insufficient circulation, for instance, in obliterant endarteritis, or to prepare the reëstablishment of cerebral circulation previously to ligature of the common carotid. Therefore in spite of the hypothetic character of it I must believe the question ought to be studied concerning the viscera and glands. I wonder if the possibility of producing locally active hyperæmia might not give us a new power of action on organs when these are becoming insufficient? Only repeated experimental researches may reveal to us what those suggestions are leading to—they are not yet begun, I offer them to your appreciation.

THE SIMPLIFICATION OF TECHNIQUE IN OPERATIONS FOR HARE-LIP AND CLEFT PALATE*

BY JAMES E THOMPSON, M D
OF GALVESTON, TEXAS

THE object of the following communication is to explain in a concise manner the anatomical faults present in hare-lip and cleft palate and to formulate rules of technic by which the deformed structures can be brought into the position they would have occupied if union of the component parts of the face and palate had occurred at the proper time, that is about the seventh week of intra-uterine life

We have never been able to explain why the edges of the embryonic fissures of the face and palate fail to unite. There is no reason to believe that the failure is due to lack of development of the lateral halves of the palate or of the alveolar border, because in almost all cases careful measurements taken soon after birth show that the superficial area of the lateral processes is quite sufficient to complete the roof of the mouth, if the maxillæ could be approximated and the palatal plates changed from their vertical to a horizontal position

The moment embryonic fusion fails, the great and probably the only agent in preventing subsequent union is the tongue, which exerts constant pressure between the edges of the cleft until it succeeds not only in prying the jaws apart, but in pushing the palatal plates upwards until they come to occupy a somewhat vertical position. The mechanism of this disrupting force can be clearly traced in every case. Whenever the gap is large enough for the tongue to be inserted, evidences of muscular pressure are always present and the direction in which the disrupted parts are moved is always that of the tongue thrust, *i e*, from behind forwards and from below upwards. Since the force exerted by the tongue is greatest at the tip and decreases gradually as we pass backwards toward the epiglottis where it reaches its minimum, we should expect to find the deformity greatest where the prying force of the tongue can be exerted to greatest advantage. The expectation is supported by the actual findings. Thus in clefts confined to the soft palate the muscular action of the posterior part of the tongue is so feeble and so ineffective as to be negligible. The slight disrupting force exerted is more than neutralized by the mobility of the muscular halves of the velum. The deformity is consequently very slight. On the other hand, in clefts extending through both soft and hard palate but stopping short at the alveolar margin, the tongue exerts considerable force on the lateral palatal plates of the maxillæ, forcing them upwards and outwards against the lateral walls of the nose and producing an unusually wide cleft. In addition the anterior and

* Read before the American Surgical Association, June 16, 1921

lateral portions of the alveolar ring are also pushed outwards to a considerable extent. But the severest degrees of deformity occur in examples of complete palatal cleft extending through the alveolar margin into the nostril. The tongue has full play and acts like a wedge driving the maxillæ apart in front so that they swing outwards like double doors on hinges which are situated behind near the posterior ends of the alveolar borders.

The principles of treatment are founded on accurate knowledge of the anatomy of the deformity, in other words, on a correct estimate of the degree of distortion. This can be measured graphically by comparing the deformed alveolar border with one reconstructed from a mold taken of the alveolar border of the mandible of the patient. In using mandibular measurements as a standard we must not forget that under normal conditions the articulation of the mandible is a little outside that of the maxillæ. (See Fig 3.) Therefore the maxillæ must be molded until the alveolar ring is a little smaller than that of the mandible.

For our purposes it will simplify matters to base the principles of treatment on an analysis of the anatomical features of a few selected common types of deformity. In this way we shall avoid unnecessary detail. To this end we have selected three types.

1 Complete unilateral cleft of the lip, unilateral cleft of the alveolar border and complete cleft of the palate

2 Complete bilateral cleft of the lip, bilateral cleft of the alveolar border and complete cleft of the palate

3 Intact lip, intact alveolar border and complete cleft of the palate

Type 1—*Complete unilateral hare-lip associated with a cleft extending through the alveolar border of the jaw and through both hard and soft palate*

Fig 1 illustrates the text. It is a life size tracing of a plaster model of a typical case of this variety of cleft. (See also Fig 6)

The points marked B and B' represent the anterior ends of the alveolar borders of the maxillæ and are placed on parts that would be in contact if the jaws had united. The distance B to B' varies within great limits. It is often as much as fifteen millimetres across. The points marked A and A' are on the alveolar border at the site of their most pronounced lateral bend. The distance A to A' indicates the greatest transverse measurement and it is always greater than it would be if the maxillæ had united. By comparing it with the corresponding measurement across the mandible an accurate estimate can be formed as to the distance the two halves of the upper jaw have been thrust apart. We have found in average cases that the measurement is several millimetres greater than it would be in a normal palate. The points C and C' mark the posterior end of the alveolar ridge. For all practical purposes this indicates the locality where the maxilla and palate bones are connected. The X represents the position of the hamular process of the pterygoid. The distance CC' is seldom increased materially. On an average the increase will not be more than one or two millimetres. The side which carries the premaxilla (the larger one marked E in the figure) always receives the full force of the tongue thrust, and in consequence its anterior end B is pushed outwards and forwards. The smaller side (E') receives very little

tongue thrust and consequently its position is changed very slightly. As a rule its alveolar border articulates fairly accurately with that of the mandible.

The lateral palatal plates deserve careful scrutiny. The mucous membrane covering each plate consists of two distinct areas, a lateral which forms a strip running along the alveolar border which is thick, rough and corrugated, and a median bordering on the cleft which is thin and smooth. The larger lateral plate (E) usually fuses with the septum. When the septal attachment is complete the nasal cavity on this side is closed off as far back as the junction of hard and soft palate. It is usually well formed and roomy, but in some instances where tongue pressure has been excessive both lateral palatal process and septum are crowded outwards, the result being that the lower portion of the septum is bent into a somewhat horizontal position near its lower attachment, and the nasal passage on this side is considerably narrowed. The smaller lateral plate E' has no attachment to the septum. As a rule it lies somewhat vertically with its free edge pointing upwards, having been pushed upwards by tongue pressure. A study of Fig 2 A and B (a coronal section of upper and lower jaws of a seven months' foetus with cleft palate) shows most of the points emphasized in the above description. The effects of the tongue thrust on the lateral palatal plates and septum are particularly evident. The smaller palatal plate is almost vertical and its free edge is opposite the septum at a point fully 2 mm higher than the attachment of that process to the other palatal plate. Its cranial surface has been squeezed against the turbinated bones of this side. The larger lateral plate is pushed upwards to a slight extent only, because the septum has acted as a buttress to protect it from pressure. The lower portion of the septum has been molded into a somewhat horizontal or slanting position.

After a careful study of a large number of models of this type of deformity the following conclusions seem to be justified.

Firstly. If embryonic union fails, the resulting deformity seen at birth can be accounted for in every detail by the muscular action of the tongue.

Secondly. That there is little or no separation of the posterior ends of the maxillæ from one another, and that any movement here is in the nature of a hinge movement by which the posterior end of the maxilla and the vertical plate of the palate bone swing on their attachments to the pterygoid processes of the sphenoid.

Thirdly. That the side to which the premaxilla and the septum are attached (the larger side) is more affected by the tongue thrust than the other maxilla, the result being that its anterior end (B) swings outwards and forwards on its hinge (situated behind at C), taking with it the septum and nose and carrying the alveolar border to a plane far outside and in front of its normal position, and further, that the attachment of the septum to the palatal plate has enabled it to withstand the vertical thrust of the tongue and to retain a reasonably good horizontal position.

Fourthly. That the other maxilla (smaller side) is displaced as a whole very slightly in a lateral direction, but that its horizontal palatal plate is seriously deformed, being frequently thrust upwards into a vertical position against the turbinate bones.

It is evident from the preceding description that the exact measure of the separation of the maxillæ from one another can be obtained from measure-

ments taken between corresponding points on opposite sides of the alveolar borders and comparing them with corresponding measurements taken across the semicircle of the alveolar border of the mandible. We have found that the measurement CC' is seldom greater than a similar measurement across the mandible. In an average case the measurement AA' is usually 2, or at most, 3 millimetres greater than normal. The distance BB' varies within great limits. It is often 10 and sometimes 15 millimetres in length. The statement made by Brophy and others that the width of the cleft is the true measurement of the extent of separation of the maxillæ is not supported by facts †. It can be true only in instances (very rare) in which the lateral maxillary processes have retained their normal horizontal position. When the lateral processes are driven into a vertical position (the greater majority) the edges of the cleft are carried with them and this factor increases the width of the cleft. As a matter of fact the true estimate of the width of the cleft is obtained by taking the sum of two displacements (1) the lateral displacement of each maxilla and (2) the vertical deviation or slant of the lateral palatal plate. From descriptions of Brophy's operations the impression is given that the edges of the cleft can be brought into contact by merely approximating the sides of the maxillæ. A glance at Fig 2 (left) will show the fallacy of this idea. Approximation of the maxillæ would bring the edge of the smaller (right) vertical palatal process against the side of the septum but could never bring it in contact with the edge of the opposite palatal process. Contact of the edges of the cleft can be secured by mere approximation under two conditions only (1) in the rare cases where the palatal plates have retained the normal horizontal position, and (2) in cases where the palatal plates have been thrust symmetrically apart. The latter condition is seen in most cases of complete cleft palate with a free septum. A little reflection, however, will convince us that approximation in the latter condition would be inadvisable, and if persisted in would result in serious disfigurement because the jaw would be narrowed to such a degree that a long, narrow beak would result.

Type 2—*Complete double hare-lip, bilateral cleft through the alveolar border, complete median cleft through both hard and soft palate*

Fig 9 is a life size sketch of a plaster mold of a typical example of this deformity

† "I have found that the upper jaw in comparison with the lower is just as much broader than it should be as is the distance between the borders of the fissures"—Brophy's Oral Surgery, p 580

"The upper jaw is just as much wider than it should be as the distance between the borders of the cleft"—Brophy's Oral Surgery, p 593

"In complete cleft palate the maxillary bones have failed to coalesce and are separated from each other by the width of the cleft. Theoretically, therefore, the approximation of these bones should bring together the edges of the cleft."—Berry and Legg, Hare-lip and Cleft Palate, p 261

The septum is massive. It hangs downward like a ploughshare and is unattached to either lateral maxillary plate. It shows a bend to the right along its whole length. Its anterior end is elongated and projects in front of the anterior ends of the maxillæ. The premaxilla is attached to the front of the septum. It forms a massive projection distinctly divided into two prominent globular swellings which contain the unerupted central incisor teeth. A small erupted tooth which represents an accessory incisor is shown attached to the lateral aspect of the right globular process. (The position of the premaxilla and the unusual length of the septum suggest excessive growth. In reality the increased length of the septum is produced by the molding and stretching of the soft bone at its anterior end by the pressure of the tongue on the globular process. Not infrequently this process assumes a horizontal position, and seems to project from the tip of the nose, the columella being almost obliterated.)

Both maxillary processes are symmetrically placed as to each other, but careful scrutiny shows that the left process has suffered more from tongue pressure than the right, in that the anterior end of the alveolar process has been pushed a little further outward and the palatal plate a little higher. The *right maxillary process* E is separated from the globular process and the anterior end of the septum by a narrow fissure, about one millimetre wide. Its alveolar margin curves round in front of the palatal plate and forms the margin of the fissure between it and the globular process. The palatal plate is well developed and shows little upward displacement. The rugose and smooth areas of mucous membrane are normally distributed. The *left maxillary process* E' is separated in front from the globular process by a distance of three millimetres and from the edge of the septum by a distance varying from five to seven millimetres. The alveolar border does not curve around the front of the palatal plate. The palatal plate occupies a higher level than that of the right side. On careful inspection it is found that the part of the palatal plate covered by rugose mucous membrane lies in its normal horizontal position, while that covered by smooth mucous membrane is vertically placed. The free edge of the cleft on this side is almost two millimetres higher than that on the right. It is evident, here, that the tongue has exerted its greatest pressure in the angle formed by the junction of septum and premaxilla and in the space between these parts and the front of the left maxillary process, and that the effect has been to thrust the maxillæ apart and to force the premaxilla forward. The measurement CC' taken across the space between the posterior end of the alveolar margin was about three millimetres greater than that across the ends of the mandible. The other measurements AA' and BB' were more difficult to fix accurately because it was next to impossible to indicate with absolute certainty corresponding points on maxilla and mandible. By comparing outlines of the superimposed molds of the alveolar border of upper and lower jaw (Fig 10) the extent of the deformity is shown in a graphic manner. From this we computed that the measurement AA' was nine mm and CC' three mm greater than normal. For practical purposes we can assume that the maxillæ have been pushed apart a distance of three mm behind, at CC', a distance of nine mm in the middle at AA' and at least nine mm in front at BB'. (The actual measurements of this specimen are given in detail on page 28.)

Type 3—Complete cleft of the palate with intact alveolar border and lip

Fig 13 is a life size sketch of a plaster mold of a typical example of this deformity. The alveolar border is frequently well formed and seems apparently undeformed. If, however, careful measurements are taken and compared with those of the lower jaw, it will be found that the greater part of the circumference of the alveolar ring of the upper jaw is expanded. The expansion affects the

middle and anterior parts of the semicircle almost entirely. As a result the lower jaw articulates well within the ring of the upper and the chin recedes. The palatal plates are often pushed into an exaggerated vertical position and as a result the edges of the cleft are placed high up in the nasal cavity and the cleft is unusually wide. This is more evident in cases where the cleft extends as far forward as the premaxilla. In the case figured the whole length of vomer stands out in relief and hangs free in the middle of the cleft. On either side of it there is a deep recess the lateral walls of which are formed by the palatal plates of the maxillæ, which have been thrust into a vertical position. The smooth area of mucous membrane is not shown in the drawing because it was out of perspective. The rugose area is well in view.

It is not necessary for our purpose to describe the anatomical features of all the numerous varieties of fissure in the lip, which are associated with the types of bony deformity which we have just described. Most of the standard operations commonly used will give excellent cosmetic results if attention is paid to the basic principles of plastic surgery and the bony deformity is corrected. We must, however, insist that correction of the bony deformity ought to precede every operation, because it is impossible to repair a lip that will satisfy critical inspection unless we have previously restored the curve of the alveolar border of the jaw, straightened the nasal septum and refashioned the anterior nasal aperture. The only way to remedy a flattened slit like *ala nasi* is to straighten the nose by restoring the pyriform aperture of the nasal cavity. A full prominent lip can be obtained only by restoring the curve of the alveolar border, which then serves as a cushion for the lip to rest upon. Once the bony deformities are remedied the repair of the lip and nostril is a matter of detail the principles of which can be enunciated under the following heads: (1) The fashioning of the nostrils (2) The making of a lip of proper depth (3) Restoration of the vermilion border and the red line of the lip.

1. *The fashioning of the nostrils.* Developmentally the margin of the nostril is formed by the union of the lateral and medial nasal processes both of which belong to the premaxilla. Cases of hare-lip are occasionally seen where the lip is cleft almost into the nostril, but the ring of the nostril is completed below by a narrow strip of skin of a triangular shape attached by its apex to the side of the columella. Fig 4B shows this developmental abnormality. In Fig 4A we see the lines of embryonic fusion along which defects may occur. Clefts in the lip proper are always due to failure of union between the maxilla and premaxilla. If we examine carefully the margin of the nostril in a case of complete cleft we will find the following appearances. On the surface of the lip just medial to the projection which forms the *ala nasi* there is a smooth area of lip which ends abruptly in a hump which forms the corner between the cleft and the nostril margin. This surface represents the triangular strip which belongs to the lateral nasal process. The hump represents the point which should be attached under normal conditions to the side of the columella. On the medial side of the

cleft, extending from the columnella there is a similar smooth area which occasionally (but more rarely) shows a similar hump or projection. If the hump on the outer horn of the nostril be brought in contact with that (or the area) on the inner horn, it will be found that the ring of the nostril will be restored. If a measurement is taken of the circumference of the sound nostril and that of the nostril restored, in this manner they will usually coincide. If there is any difference it will be caused by the difficulty in fixing the point on the median side (columnella) to which the projection on the lateral side is opposed, because quite frequently the projection is wanting on the former. If there is no projection on the median side of the columnella, we bring the projection on the lateral corner of the cleft over to the side of the columnella until the circumference of the nostril is restored accurately. We then fix this point indelibly by transfixing it with a horsehair stitch. We then have the two corners of the horn fixed, and if care is taken not to shave them when the sides of the cleft are being pared, the restoration of the nostril will be perfect. If these details are carried out scrupulously the ala nasi will be carried into the position it ought to occupy, *i e*, it will be carried medially and upward, and its natural curve restored. Careful comparison with the sound nostril is necessary.

2 *Making a lip of the proper depth* In cases of single hare-lip, the exact depth of the lip required can be determined accurately by measuring on the sound side, directly downward from the lower margin of the nostril to the mucocutaneous margin. Screw compasses with sharp points are used for this purpose. We then measure the same distance from the hump or projection (or suture), previously fixed at the margin of the nostril, to the mucocutaneous junction on either side of the cleft and fix the place indelibly by a prick of the point of the compasses. This measurement fixes the length of the lateral incisions required to make the lip deep enough when the sides of the cleft are pared and brought together.

3 *Restoration of the vermillion border of the lip so that the mucocutaneous junction runs continuously from side to side without a break and the mucous membrane is of the proper depth* Approximation of the sites of the punctures made at the mucocutaneous junction by the point of the compasses after the edges of the cleft have been pared, will restore the red line of the lip accurately. Proper depth of mucous membrane is obtained by measuring from the mucocutaneous puncture to a point on the free margin of the lip, near the corner of the cleft, a distance a little greater than the vertical depth of the mucous membrane immediately below the puncture. This point is fixed by pricking with the compasses. A similar point is fixed on the opposite side of the cleft. We have then fixed definitely by measurements three points on each side of the cleft, one at the upper corner of the cleft, another at the mucocutaneous junction and the third at the free edge of the lip. The lip is now transfixed by a cataract knife at the point on the mucocutaneous junction. From this point it is carried upward with a

slight outward curve and cuts its way into the cleft just median to the hump (or puncture) at the margin of the nostril. The mucous membrane of the lip is then divided by an incision which passes from the puncture on its free margin to the point of transfixion. The procedure is then repeated on the opposite side of the cleft. This produces two lines of incision apposed to one another that will coincide accurately if the points previously marked are brought into contact. The steps of this procedure are shown in Fig 5 (1, 2, 3 and 4)

The foregoing description applies to cases of single hare-lip. Double hare-lip requires special consideration. The area of lip attached to the premaxilla which under normal conditions forms the philtrum is usually very small. Quite frequently it forms a small projection with a free semicircular border attached to the end of a short, poorly formed columella. It appears to stick out from the end of the nose. It can rarely be used, as was the developmental intent, to make the whole depth of the new lip, because it is too short to cover the alveolar border of the premaxilla, much less the incisor teeth after eruption. It is therefore used to form the upper medial portion only of the new lip. The lower part is formed by bringing the lateral (maxillary) portions of the lip together in the middle line below the philtrum. From an embryological point of view the method is imperfect because the central portion (or philtrum) of the new lip is not obtained exclusively from the premaxillary covering. The usual way in which the soft parts are approximated is the following. The premaxillary lip is carefully pared either into a triangular or semicircular form by removing all the mucous membrane from nasal corner to nasal corner. Then the lateral margins of the cleft are pared according to the rules previously laid down. Care is taken that the distance AB must always be greater than the distance ED, otherwise when the parts are brought together the point D would lie between B and B' and would break the line of the vermilion border of the lip. It is very seldom that the central part of the lip is deep enough to necessitate such precaution. The steps of the procedure are shown in Fig 5 (5 and 6)

(The above description is a modification of that previously described by the author in *Surgery, Gynecology and Obstetrics*, May, 1912, pp. 494 to 505.) Results of the operations are shown in Figs 25, 26, 27 and 28

Now we are in a position to trace step by step the operative procedures required to restore the jaws, lip and palate as closely as possible to their normal state

For many years it has been my aim to finish the work at as early an age as possible, because I felt sure that the chances of normal speech would be favored if the palate could be closed before the child learned how to talk. It has been my custom for many years to operate on the lip and alveolar border as soon after birth as possible. I have postponed the operation on the palate to a much later date for two reasons. First, because very early operations on the palate are attended by a high mortality, and secondly, because the

operation is easier to perform when the baby is older After the age of six months most well-nourished babies are strong enough to undergo palate operations and there is comparatively little danger to life if the operations are short in duration and attended by slight loss of blood In one case of unilateral complete cleft of the lip, associated with cleft of the alveolar border and complete cleft of the palate, repair of lip and palate was completed when the baby was five months old This is the earliest date in my series (Case II, J H Second alternative) The next earliest case was six months old at the time of the operation on the palate (Case I, M R First alternative) Both were favorable cases The babies were exceptionally robust and the clefts were narrow In the great majority of cases we are fortunate if we can complete the closure of the palate before the child begins to talk Even under the most favorable conditions, for one reason or another, the babies will be a year or eighteen months old before the work can be completed Double hare-lip, associated with complete cleft of the

TABLE

Operation	First alternative	Second alternative	Thrd alternative	Fourth alternative
First	Lip and alveolar border	Lip, alveolar border and anterior part of palate	Alveolar border and anterior part of palate	Alveolar border
Second	Palate Complete at one sitting (rare) or anterior part only	Palate Posterior part	Lip	Lip
Thrd	Palate Posterior part		Palate Posterior part	Palate Complete at one sitting (rare) or anterior part only
Fourth				Palate Posterior part

alveolar border and complete cleft of the palate, stands in a class by itself, and complete closure of these palates is rarely possible before the end of the second year

The types of deformity described previously will now be taken in order and each stage of the reconstructive process taken up step by step

Type 1—*Complete unilateral hare-lip, unilateral cleft of the alveolar border and complete cleft of the hard and soft palate*

Occasionally when the cleft is narrow reconstruction can be completed in two stages Usually three operations are needed and in a few cases four Each case is a law unto itself The sequence of the operative stages is determined by the nature of the first operation and the extent of reconstruction accomplished at this time The attached table shows in a graphic manner the complete dependence of each subsequent operation on the first It is an accurate mirror of my own practice In the text the scheme will be followed as closely as possible

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In my earlier work I followed the operative sequence given in the "*first alternative*" and found that the results were very satisfactory. There was, however, one serious objection. In the second operation it was very difficult to repair the extreme anterior end of the cleft in the hard palate, and as a result a small opening persisted that was very hard to close. This led us to try the "*second alternative*," in which we were ambitious enough to try to repair alveolar border, anterior part of hard palate and lip in one sitting. We found that the results were satisfactory and that the palate could be closed subsequently in one operation. Unfortunately, the operation was followed by severe shock and was unsafe unless the baby was unusually well nourished and robust. This led us to employ the "*third alternative*," in which alveolar border and anterior part of palate were repaired at the first operation and the lip and posterior part of the palate at later and separate operations. As our experience grows we are gradually adopting this procedure as the one of choice, reserving the first alternative to those cases where we wish to gratify the desire of the parents to have the lip closed as soon as possible. The "*fourth alternative*" is rarely employed in unilateral clefts of the alveolar border. It is reserved almost exclusively for bilateral clefts of Type II.

We shall now proceed to describe step by step the operations included under the heading of the "*first alternative*"

FIRST ALTERNATIVE

FIRST OPERATION—REPAIR OF ALVEOLAR BORDER OF LIP

The first step is to separate the lips and cheek from the underlying maxillæ over the greater part of their outer surface. Bleeding will be slight if the soft parts are pushed from the bones by sponge pressure after the mucous membrane is divided. Then the maxillæ are pushed together by thumb pressure exerted on the prominent maxillary process. Referring to Fig 6, pressure is applied to the body of the maxilla in the direction of the arrow and the bone is pushed over until the distance AA' is reduced to its proper corrected length. The line of pressure is changed, passing forward gradually toward the point B, until the ends of the alveolar margins B and B' are brought into contact. Care must be taken to mold the body of the jaw and not the alveolar processes, otherwise they may bend inward and the body of the jaw may remain in its original position. The molding must be done thoroughly and we must not desist until most of the resiliency of the jaw has been overcome and the points B and B' show little tendency to spring apart. In children over three months of age digital molding alone may be impossible and it may be necessary first to divide the body of the jaw by a transverse cut either by a knife or by a chisel. The line of incision in the bone should be just below the malar buttress of the maxilla and it must always be above the sockets of the teeth. Afterwards the parts are molded and brought together. Molding of the smaller side of the maxilla is seldom necessary because its lateral displacement is slight. The coapted maxillæ are now fastened together. For several years I have been using kangaroo tendon to hold the bones in place. The mucous membrane is removed from the ends of the alveolar borders at B and B'. In doing this thoroughly we sometimes open the socket of a tooth, which necessitates its removal. A drill is passed through the body of each maxilla, entering

on its outer surface above the sockets of the teeth and well behind the pyriform aperture of the nose. It enters the nasal cavity above the horizontal palatal plate. Along the track of the drill an Emmet needle is passed carrying a silk thread, which is used in turn to pull a strong strand of kangaroo tendon along the track. The maxillæ are finally brought close together and the tendon knotted in front. If care is taken perfect approximation is secured. At this stage of the operation it will be found that the nose is straightened, the pyriform aperture of nose restored and the sides of the alveolar border approximated. The margins of the cleft in the lip now lie quite close to one another. If the child's condition is good it is our custom to repair the lip at once. The edges of the cleft are pared and the operation is completed according to the technic described previously.

The results following the use of kangaroo tendon have been very satisfactory. It has failed me in one case only, and the reasons for this were probably twofold, *viz*, (1) inadequate molding of the maxillæ, (2) the use of a strand of tendon too thin to stand the strain. It is absolutely necessary to mold until the resilience of the bone is completely overcome, otherwise the kangaroo tendon will not stand the strain. If resilience cannot be destroyed it is far safer to fasten the bones together with silver wire, either with or without the use of lead plates. As a matter of fact, the only reason for using kangaroo tendon is that it enables us to close the lip at the same sitting without the worry of contemplating the subsequent removal of a silver wire from underneath the freshly united lip. In all two-stage operations on the alveolar border and lip silver wire is preferable and safer.

SECOND OPERATION—REPAIR OF THE PALATE

We allow a period of from four to six months to elapse between the operation on the lip and alveolar border and that on the palate. At this time we find that the palate is fairly accessible and that the lip will stretch to any reasonable extent. In favorable cases the palate can be repaired in one sitting. In the great majority two separate operations are required.

1 Complete repair in one sitting

A tension suture is passed on each side through the whole thickness of the anterior part of the soft palate. These sutures are retained until both soft and hard palates are completely mobilized. They are used exclusively as tractors and their employment reduces the handling and injury of the palate to a minimum. The mucoperiosteum of the hard palate is now divided down to bone by an incision (Langenbeck's) close to and parallel with the alveolar border. The incision should be about a centimetre in length and should not endanger either the anterior or posterior palatine arteries. Through this incision the mucoperiosteal layer is separated by an elevator from the bony palatal plate over its whole area of attachment, from front to back and from the alveolar margin to the edge of the cleft. The separation from the edge of the cleft can usually be done by the elevator, aided by occasional snips from sharply curved scissors. On the side of the maxilla to which the septum is attached care must be taken to avoid separating the mucous membrane from the side of the septum unless it is the intention to use it as a flap. A lateral incision through the septal and palatal union from front to back can be made with a flat curved knife and this will facilitate the elevation of the palatal flap on this side. Next the attachment of soft palate to the posterior border of hard palate is divided. This (palatal apo-

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neurosis) can be divided best by pulling on the tension stitch, elevating the soft palate and cutting the resisting tissue with curved scissors. At this stage both soft and hard palate can be lifted towards the operator, and if the separation is adequate the flap will lie horizontal in the mouth. The same procedure is repeated on the opposite side. Too much emphasis cannot be laid on the importance of doing this part of the operation thoroughly. No important blood-vessel is imperilled if the directions are followed as described above. At this stage, if the cleft is very narrow, the edges of the palatal flaps can often be brought together without tension, and after being pared they can be fastened together by a special technic (Brophy's plates) with good prospects of primary union. (The essential features of Brophy's method are the following. Two silver wire sutures are passed through the whole thickness of the soft palate on each side, penetrating it near its lateral attachment. The ends of these wires are passed through holes punched in an oblong-shaped lead plate which is trimmed to fit the case. The plate rests on each side on the fleshy part of the velum internal to the hamular process. The edges of the cleft are pared and united by sutures from end to end. Finally the lead plates are adjusted and the silver wires tightened and knotted on each side. Great care must be taken to secure the right degree of tension on the plates. If this method can be carried out, the functional results are much superior to those obtained by the methods to be described later, because the soft palate sustains no injury. Whenever possible Brophy's method should be used. Unfortunately in very young babies conditions are rarely favorable and we are forced to secure complete relaxation by division of the soft tissues. We never hesitate, however, to use metal plates whenever there is any tension on the flaps.) In wider clefts the edges of the palatal flaps cannot be approximated at this stage without tension, and at any hazard this must be avoided. Tension can be lessened by increasing the length of the lateral incision. It can be carried forward a considerable distance without cutting the anterior palatine artery, and, if care is taken to keep very close to the alveolar margin of the jaw and follow its posterior curve accurately, it can be carried backward as far as the level of the hamular process without danger of wounding the descending palatine artery. It is our custom to carry the incision around the posterior margin of the alveolus in a short hook, and then to cut backwards, through mucous membrane only, towards the middle of the tonsil along a line just lateral to the hamular process. The edges of the incision in the mucous membrane gape widely and the palate can be dislocated bodily from the maxilla towards the median line without cutting any of its muscles. If further liberation is necessary division of some of the muscles of the soft palate is unavoidable. We believe that division of the muscles on the anterior surface of the palate is wrong in principle because there is serious risk of wounding the radiating branches of the descending palatine artery if the buccal surface of the palate is incised. The palatal muscles on the posterior or cranial surface of the velum can be divided without this risk. We have found that division of the palato-pharyngeus and levator palati produces complete relaxation. They can be divided safely in the following manner. If the soft palate is elevated by the tension stitch both palato-pharyngeus and levator palati muscles can be brought into view (Figs 15 and 16). The palato-pharyngeus muscle and the mucous membrane covering it are divided with scissors at a point just behind the middle of the tonsil. By cutting deeply into the lateral wall of the nasal passage with the scissors along a line drawn from the divided palato-pharyngeus to a point just buccal to the orifice of the Eustachian tube the levator palati will be divided. Vigorous elevation of the velum by the tension stitch will put this muscle on the stretch and it will produce a marked elevation under the mucous membrane. Paring of the edges of the flaps is the

next stage In the hard palate this is unnecessary if mattress sutures are used, in the soft palate it must be done thoroughly and with the greatest care The mucous membrane must be removed in a single complete strip to avoid leaving small islands behind On each side the soft palate is transfixed by a cataract knife and a thin strip of mucous membrane is removed from its free edge extending from the tip of the uvula as far forward as the junction of soft and hard palate

The last stage is the passing of the sutures It is often convenient to secure control of each side of the palate by means of tension stitches Usually we insert three on each side, one in front, another at the junction of hard and soft palate and a third through the thickness of soft palate lateral to the uvula Blair prefers to handle the palate by means of a tenaculum made by fixing the broken point of a sewing needle in the jaws of a pair of forcipressure forceps The first suture is passed through both edges of the cleft at the junction of hard and soft palate This is not tied but is merely used to lift up the flaps and to secure accurate spacing of the rest of the sutures The sutures are now passed systematically from before backwards Each stitch is of the mattress type, inserted in such a manner as to avoid strangulating the blood supply to the edges of the flap (vertical mattress stitch, see Fig 14) Three or four stitches may be required in the hard palate When tied the raw (upper or cranial) surfaces of the flaps are opposed to one another and the edges of the flaps are turned out like the flange in a water pipe Similar stitches are passed in the soft palate, care being taken not to penetrate through mucous membrane on its cranial surface By proceeding systematically from before backwards, and using the last stitch passed as a tractor to hold up the flaps while the next stitch is inserted, little trouble is experienced in placing the sutures in good position All the stitches are of the mattress variety except those in the uvula, which are of the ordinary through-and-through variety The suture material varies For the mattress stitches we have lately been using carefully selected fine silkworm gut For the other stitches we use horsehair or fine silk

In Fig 17 the steps of a palate operation, which was completed in one sitting, are shown Reconstruction of lip, alveolar border and palate was finished at the age of six months At the first operation lip and alveolar border were repaired At the second operation both hard and soft palate were repaired

2 Repair in two sittings Cases requiring the two-stage operation must be picked with the greatest care They bristle with possibilities of failure, and if an unsuccessful operation is attended by sloughing of the flaps subsequent reconstruction may be impossible

It is a generally accepted fact that a cleft will become proportionally narrower and that the area of available flap will increase as time passes Many cases with wide clefts and high palatal plates which are quite inoperable in the first year of life pass into the operable class at the end of the second year Therefore it is wise to wait until measurements of the available tissue show that the operation can be undertaken with a reasonable prospect of success In these cases it is better to divide the operation into two stages, first closing the hard palate and later the soft It is impossible to lay down hard and fast rules of procedure because each case must be judged on its own merits It is better to attempt too little rather than too much and to be content with closing the anterior part of the cleft without inflicting any injury on the velum, because if the velum is rendered hard and cicatricial, the last stage of the operation on the soft palate will be made very difficult and primary union problematical

The steps of the *first stage* of the operation are essentially the same as those previously described We always use the liberating side incisions (Langenbeck)

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and lift the mucoperiosteal flaps from the underlying bone very thoroughly. The palatal aponeurosis is divided and each flap is then freed. Of recent years we have made it a point to secure a flap from the side of the septum as shown in Figs 18 and 19. By this means the area of available flap has been increased materially. The edges of the two flaps are approximated and united by vertical mattress sutures as described previously. The sutures pass backward only as far as the junction of hard and soft palate. The velum is not encroached on in the slightest degree. As a rule union is sure and firm. The stitches very rarely cut out. At the worst, the hind stitch may give way.

The *second stage* is performed two or three months later. It is carried out in every detail as described previously. We find it necessary to make large, liberating side incisions along the old tracks and through these the mucoperiosteum of the reformed hard palate is lifted up once again from its bony attachment and the palatal aponeurosis divided on each side. Not infrequently the side incisions are carried very far back and curved around the posterior end of the alveolar border. At any hazard both hard and soft palate must be lifted up from its bed until it hangs free. Finally the levator palati and palatopharyngeus are divided and tension on the soft palate relieved, after which the edges of the cleft are denuded and the sutures inserted "*secundum artem*"

Figs 18 and 19 with the legends attached are typical examples of cases operated on by the "first alternative" followed by two-stage operations on the palate. They are particularly instructive because each one was left with a small hole in the front of the palate just behind the alveolar border. This was closed in Fig 19, by means of a tongue-flap sliding operation. Final closure of these small holes in front was so troublesome that we cast about for means to avoid the complication. In our first attempts the lip and alveolar border were repaired, and the anterior part of the cleft closed at the same sitting by elevating and sliding across the gap small mucoperiosteal flaps taken from the palatal plates. Such a case is shown in Fig 20. Suture and adjustment of the flaps was very difficult and subsequent elevation of the mucoperiosteal layer in the later palate operations doubly so. Eventually we were led to use the mucous membrane of the septum in the flap and to formulate the sequence of operations comprised under the "second alternative"

SECOND ALTERNATIVE

In this the first operation aims to mold the jaws, suture the alveolar border, repair the anterior part of the palate and close the lip in one sitting. At a subsequent sitting the remainder of the palate is repaired. The first case on which this procedure was tried was singularly successful. The first operation was followed by very little shock and the results were so satisfactory that reconstruction was completed at the age of five months. Fig. 21 shows the palatal procedures used in this case. In another case, shown in Fig 22, the operation was successful, apart from a slight failure of union at the junction of hard and soft palate, which necessitated a third operation for its repair.

The details of the method are as follows Before the jaws are molded, while the cleft is still wide open, a rectangular flap is reflected from the septum, downward to the margin where the palatal and septal mucosa unite To secure freedom of this flap the mucoperiosteum is detached over a narrow area from the under surface of the contiguous palatal plate along the whole line of the septal attachment This flap is carefully held up with tension stitches to avoid bruising On the other side of the cleft the edge of the mucoperiosteum of the hard palate is raised up along the whole length of its free margin and separated from the palatal plate until its deep raw surface is freely exposed Langenbeck's incisions are used on each side Tension stitches are used to hold the edges of this flap The jaws are now molded, approximated, and the kangaroo tendon suture passed but not tied The edges of the alveolar margin are then pared At this stage the raw surfaces of the palatal flaps are approximated and vertical mattress stitches of silk worm gut are inserted If the flaps are long enough the stitches can be tied at once without danger If, however, there is any tension, the tying of the stitches must be left until the last stage of the operation Next the alveolar borders are approximated, the kangaroo tendon tied, and finally the palatal stitches are tied

Our subsequent experiences with the procedure showed that the first operation is attended with serious shock In one baby, death undoubtedly resulted from a miscalculation of the seriousness of the procedure We, therefore, at the present time perform it only in babies who are exceptionally well nourished and robust

THIRD ALTERNATIVE

Gradually we are coming to the conclusion that the sequence of operations comprised in the "third alternative" offers the greatest degree of safety and enables us to secure the best cosmetic results The only drawback is a sentimental one, in that we postpone the repair of the lip to the second operation and so prolong the suspense of the parents, otherwise, we divide the stages in an ideal manner and secure the most satisfactory reconstruction At the first operation we repair the alveolar border, mold the jaws and repair the anterior part of the palate The jaws are held together with silver wire (preferably) or kangaroo tendon Brophy's side plates are used only in cases where molding is difficult and the resilience of the jaws cannot be overcome completely The wires and plates are removed at the end of two weeks and the raw surfaces allowed to heal up completely before the second operation on the lip is performed Four to six months after the lip has been repaired the posterior part of the palate is repaired "secundum artem"

FOURTH ALTERNATIVE

Practically no cases of Type I in babies should be treated by sequence comprised under the "fourth alternative" A few neglected cases in adults would necessarily fall in this category As stated before, the sequence becomes necessary in treating cases of Type II, which comprise bilateral clefts of the alveolar margin and complete cleft of the palate

OPERATIONS FOR HARE-LIP AND CLEFT PALATE

Type II — *Bilateral complete hare-lip, bilateral cleft of the alveolar border, complete cleft of the palate*

We have previously described the type of plastic operation that gives uniformly good results in cases of complete double hare-lip. Before this operation is undertaken it is necessary to correct the forward projection of the premaxilla and to place it in proper position between the anterior ends of the maxillæ. The outward displacement of the maxillary processes is first corrected. By thumb pressure aided by division of the bone by a chisel or knife, as may be necessary, the maxillæ are pushed towards the middle line until they are approximated to the right degree as verified by measurements with calipers. The premaxilla is then forced backwards until it lies between and a little in front of their anterior horns. Removal of a wedge-shaped portion of the septum allows the bone to slip backwards smoothly. Care must be taken not to jam the premaxilla too far back between the ends of the maxilla. It must always lie a little in front of the projecting edges of the latter bones. If placed too far back, the profile view of the upper lip will be ugly and flattened. When these preliminaries are completed, the mucous membrane is removed from the margins of the cleft on the front of the maxillæ and from the contiguous sides of the premaxilla. Finally the maxillæ and premaxilla are firmly united by strong silver wire sutures fastened over lead plates placed on the sides of the maxillæ, according to the method of Brophy. It is better not to attempt to close the cleft in the lip at this time because it is essential that this stage of the operation should succeed. In three or four weeks the silver wires and lead plates can be removed, and as soon as the gums have healed completely and the mouth is surgically clean, the lip can be repaired. At the second operation the lip is repaired "secundum artem." We invariably use the method described earlier in this paper. The appearance of a double hare-lip immediately after the operation is never as satisfactory as that of a single lip. The nostrils are frequently unsightly, the openings of the nares look forwards instead of downwards, and the tip of the nose is often puckered downwards by the short columella. As time passes these ugly features get smoothed out in a remarkable manner. A period of six months is allowed to pass before any operation on the palate is attempted. Careful measurements are made of the width of the cleft and of the amount of tissue available for flaps, and a judicial estimate made as to the possibilities of a successful plastic operation. If there is the slightest deficiency in the area of available flap, the operation must be postponed without hesitation. However anxious we may be to close the palate before the child learns how to talk, it is far better to wait, rather than run the risk of failure. As time passes we find that the picture changes. The cleft gets narrower, the distance between the alveolar borders decreases and the area of mucoperiosteum on the palatal plates increases considerably. The following observations taken on one of our cases corroborate these statements in every particular. Reference to Figs 9, 10, 11 and 12 will explain the text.

viously described under Type II At the first stage the hard palate is repaired by sliding a tongue flap across the gap and uniting it to the edge of the opposite flap which has been raised by the Langenbeck method The operation is confined entirely to the hard palate A few months afterwards, when the flaps forming the hard palate are thoroughly vascularized and consolidated, the second stage is undertaken and the remainder of the palate repaired "secundum artem" Fig 24 represents an example of this type, in which complete repair of a very wide cleft was obtained in two operations according to the method described

The following abstract of cases has been prepared to illustrate the nature and sequence of operations on the palate They have been arranged to fit in with the scheme embodied in the table of sequences as First, Second, Third or Fourth alternatives We have purposely omitted reports of cases falling under the third alternative because the true value of this sequence is still "sub judice" We are enthusiastic over the results obtained, but at the present time are not prepared to recommend it unreservedly

FIRST ALTERNATIVE

CASE I—M R, aged six weeks Right complete harelip, cleft of the alveolar border, complete cleft of hard and soft palate

First operation July 17, 1918 Repair of lip, molding of maxillæ, repair of alveolar border, suture with kangaroo tendon Result perfect primary union

Second operation (Fig 17,) aged six months, December 11, 1918 Repair of whole length of palate, Langenbeck's side incisions, silver wire tension stitches fastened over metal plates Mattress sutures of silver wire and horsehair, Result primary union A very small opening was left in front just behind the alveolar border (December 27th the right nostril which was too large was narrowed by a plastic operation)

CASE II—F C, aged three months Left complete harelip, cleft of the alveolar border, complete cleft of hard and soft palate

First operation December 10, 1918 Repair of the lip, molding of the maxillæ, repair of the alveolar border, suture of the maxillæ with kangaroo tendon Result Primary union

Second operation June 28, 1919 Aged ten months Hard palate repaired by taking a flap from the side of the septum Langenbeck's side incisions used Mattress sutures of silver wire and silk Result, primary union A small hole persisted in front just behind the alveolar border (See Fig 18 First palate operation)

Third operation November 4, 1919 Repair of the posterior part of the palate Small hole in the anterior part of the palate almost imperceptible Langenbeck's side incisions carried far back Mattress sutures of silver wire and silk-worm gut Result primary union (See Fig 18 Second palate operation)

CASE III—J C, aged one month Right complete harelip, cleft of the alveolar border, complete cleft of hard and soft palate

First operation March 13, 1919 Repair of the lip, molding of the maxillæ, repair of the alveolar border, suture with kangaroo tendon Result primary union

Second operation Aged four months June 6, 1919 Hard palate closed by using a flap taken from the septum Langenbeck's side incisions employed Result good Union complete along greater part of length of hard palate A

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small hole persisted in front just behind the alveolar border (Fig 19 First palate operation)

Third operation Aged eight months October 23, 1919 Repair of posterior part of hard and whole of soft palate Langenbeck's side incisions No attempt made to close hole in front just behind alveolar border Result complete healing (Fig 19 Second palate operation)

Fourth operation Aged one year February 25, 1920 Repair of hole in anterior part of the hard palate Langenbeck's side incisions and complete separation of flap A which was made to slide over to the right Result complete healing (Fig 19 Third palate operation)

SECOND ALTERNATIVE

CASE I—E B, aged seven months Left complete harelip, cleft of the alveolar border, complete cleft of hard and soft palate

First operation July 18, 1919 Repair of lip, molding of maxillæ after chiseling through malar buttresses, repair of alveolar border, suture of maxillæ with kangaroo tendon Repair of extreme anterior end of hard palate after liberation of flaps by small side incisions Result primary healing (Fig 20 First operation)

Second operation Aged ten months November 11, 1919 Repair of whole length of hard palate by using septal flap and making Langenbeck's side incisions Result failure of union caused by sloughing of edge of the flap on the left side (Fig 20 Second operation)

Third operation postponed until baby was two years old November 22, 1920 Repair of hard and soft palate at one sitting Langenbeck's side incisions used Result excellent Primary union (Fig 20 Third operation)

NOTE—In this case the attempt to close the anterior part of the palate at the first sitting was successful as far as it went We succeeded, however, in closing only a very short length and did not use a septal flap In the second operation the cleft was so wide that a septal flap was needed The operation was very difficult The result was that most of the line of union failed to heal We never repeated the technique of the first operation In subsequent operations we always used a septal flap The case may be considered as a transition from the first to the second alternative

CASE II—J H, aged one month Right complete harelip, cleft of the alveolar border, complete cleft of hard and soft palate

First operation March 31, 1920 Repair of lip, molding of maxillæ repair of anterior part of palate by a septal flap Result excellent, primary union (Fig 21 First operation)

Second operation July 28, 1920, aged five months Repair of posterior part of the palate, Langenbeck's side incisions Double silver wire tension stitches fastened over buttons Suture of silver wire and horsehair Result primary union Complete repair (Fig 21 Second operation)

CASE III—F N, aged six weeks Right complete harelip, cleft of the alveolar border, complete cleft of hard and soft palate

First operation March 17, 1920 Repair of lip, molding of maxillæ, repair of alveolar border, suture of maxillæ by kangaroo tendon, closure of front part of cleft in hard palate by means of a septal flap Result primary healing (Fig 22 First operation)

Second operation Aged six months, July 10, 1920 Repair of posterior part of palate, cleft very wide, area of velum very narrow Langenbeck's side incision carried far back, especially on right side where it encircled posterior border

of alveolus Result failure of union at junction of hard and soft palate Side of velum united (Fig 22 Second operation)

Third operation Aged ten months November 4, 1920 Condition as follows Two holes present, one anterior showed as a median slit occupying posterior quarter of hard palate, the other laterally placed at junction of hard and soft palate (Fig 22 Third operation) Palate closed after being liberated thoroughly by incision shown by dotted lines The rectangular piece outlined by the dotted line was excised and the raw edges united by four silver wire sutures

FOURTH ALTERNATIVE

CASE I—M F, aged five months Complete bilateral harelip and complete cleft of the palate, vomer free, very prominent premaxilla (For sketch of cast of palate, see Fig 9)

First operation November 19, 1918 Molding of maxillæ and replacement of premaxilla after excision of a triangular piece from the septum Silver wires and plates used according to Brophy's technique Result good

Second operation December 12, 1918 Repair of double harelip according to method described previously Result primary union lip excellent On May 1st, 1919, a mold of the palate was taken, a sketch of which is shown in Fig 11

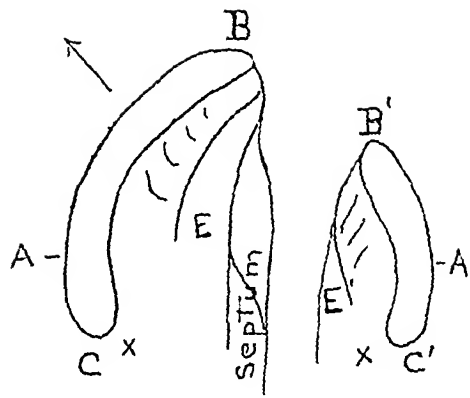
Third operation June 1, 1920 The anterior part of the palate was closed by a modification of Langenbeck's operation A tongue shaped flap was lifted up from the left side and dissected up as far back as the junction of hard and soft palate On the right side the flap was lifted up as in Langenbeck's procedure, the free edge being lifted up very carefully along the whole length of hard palate After sliding the tongue flap across the cleft the edges were fastened together with mattress stitches Result primary union (See Fig 23 First palate operation)

Fourth operation April 14, 1921 (Refer to Fig 12, a sketch of a plaster mold) Repair of posterior part of palate Langenbeck's liberating side incisions carried backwards and curved around the posterior end of the alveolar ridge, incision through mucous membrane carried from bend of curve towards tonsil Liberation of hard palate from bone, division of palato-pharyngeus and levator palati muscles Silver wire tension stitches fastened over metal plates, mattress sutures of silkworm gut Result primary union (See Fig 23 Second palate operation, and Fig 12, a sketch of a plaster mold of reconstructed palate)

CASE II—R.H McM aged eleven days Double harelip, alveolar border grooved but not cleft, complete cleft of palate behind alveolar border Septum free Cleft unusually wide along its whole length Lip repaired at once June 26, 1919 Result good

Second operation on anterior part of palate March 23, 1920 On right side of palate mucoperiosteal flap elevated through a long Langenbeck side incision On left side mucoperiosteal flap lifted up from bone like a tongue and separated from the posterior margin of bony palate The tongue flap was carried sideways across the cleft and its free edge united by mattress sutures with that of the opposite side No attempt was made to close the posterior end of the cleft Result primary union along the whole length of repair (Fig 24 First palate operation)

Third operation March, 1921 At this time a very small hole was present just behind the alveolar border Behind this the hard palate was firmly united to a point on a line of junction of hard and soft palate Liberating side incisions carried well backwards around the posterior ends of the alveolar margins Division of palato-pharyngeus and levator palati muscles Cleft was very wide and palate had to be loosened very extensively Suture with silkworm gut mattress stitches Result primary union (Fig 24 Second palate operation)



Shaw

FIG 1 —Life sized sketch of a plaster mold of the palatal surface of the maxillary plates of a case of unilateral cleft of the alveolar border and complete cleft of the palate. The letter E is placed on the right maxillary plate to which septum and premaxilla are attached. The letters A B and C refer to points on the alveolar border which are described in the text. The cross is placed over the hamular process. The arrow shows the direction in which the larger plate is forced outwards by the tongue thrust.



FIG 2 A —shows photographs of the head of a seven months foetus in which a complete cleft of the lip alveolar border and palate was present. On the right the external appearance of the flaring nostril and the cleft in the lip are well depicted. The tongue and alveolar margin of the mandible stand out in relief. On the left we see a coronal section of the face passing through the middle of the palate. The anatomical features of both photographs are emphasized and labelled accurately in Fig 2 B.

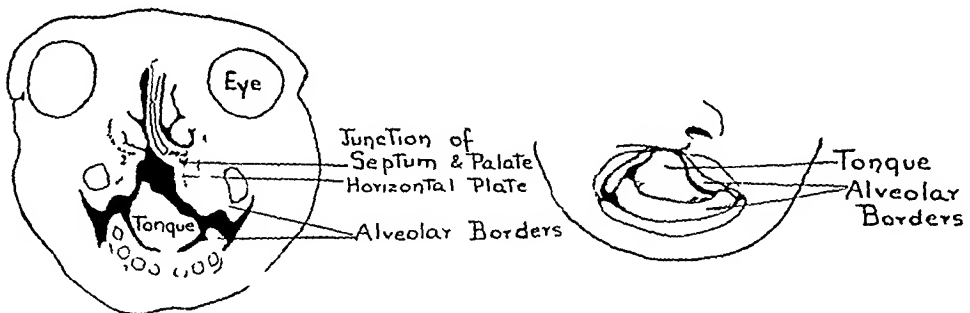


FIG 2 B —Drawing of previous figures to show the exact relations of the palatal plates to one another and the exact boundaries of the cleft. The site of fusion of left palatal plate and septum is indicated by an acute bend. The lower part of the septum is bent like a hockey stick. Both palatal plates have been pushed into a vertical position. The free edge of the right palatal plate (left in the figure) is considerably higher than that of the left. The alveolar border of each maxillary process lies outside that of the mandible. Under normal conditions the alveolar border of the mandible should lie a little outside that of the maxilla. The tongue occupied the space between the separated maxillae. The apex of the triangular-shaped section was placed between the edge of the left maxillary plate and septum.

OPERATIONS FOR HARE-LIP AND CLEFT PALATE

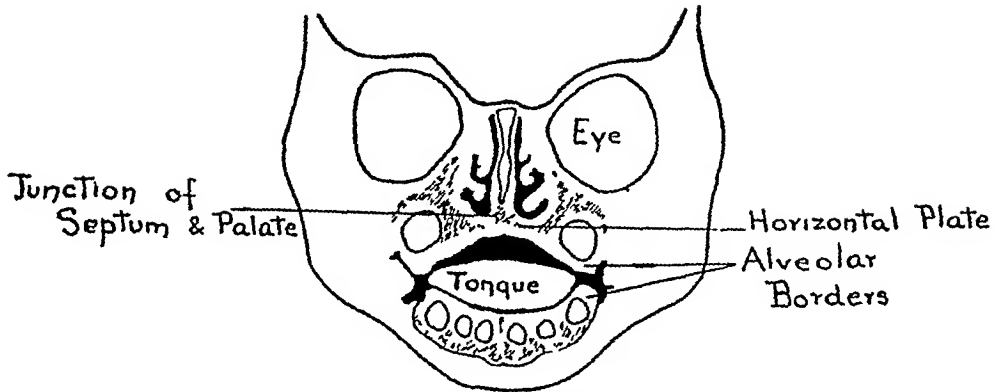


FIG 3.—A drawing of a coronal section of the face of a normal foetus at term. The palatal plates and septum have united. Note the shape of the tongue molded to the normal palatal arch. The alveolar border of maxilla and mandible articulate with each other accurately on the left side. On the right that of the maxilla is slightly outside the alveolar border of the mandible.

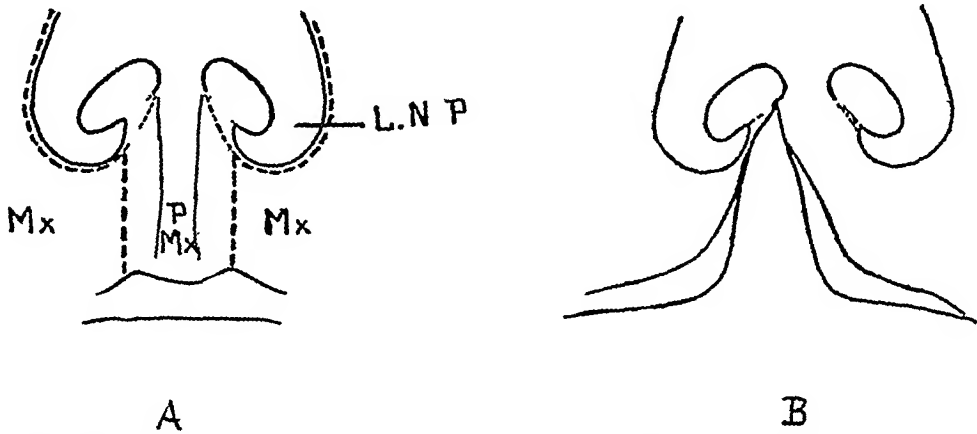


FIG 4.—The figures show in the lip and nostril the lines of fusion of maxilla and premaxilla which is emphasized by the dotted line. The ring of the nostril is completed below by the fusion of external and internal nasal processes. This is indicated in A by a triangular area bounded by black dots. In B an example of incomplete hare-lip is shown, in which the margin of the nostril is intact the lower part being formed by the external nasal process.

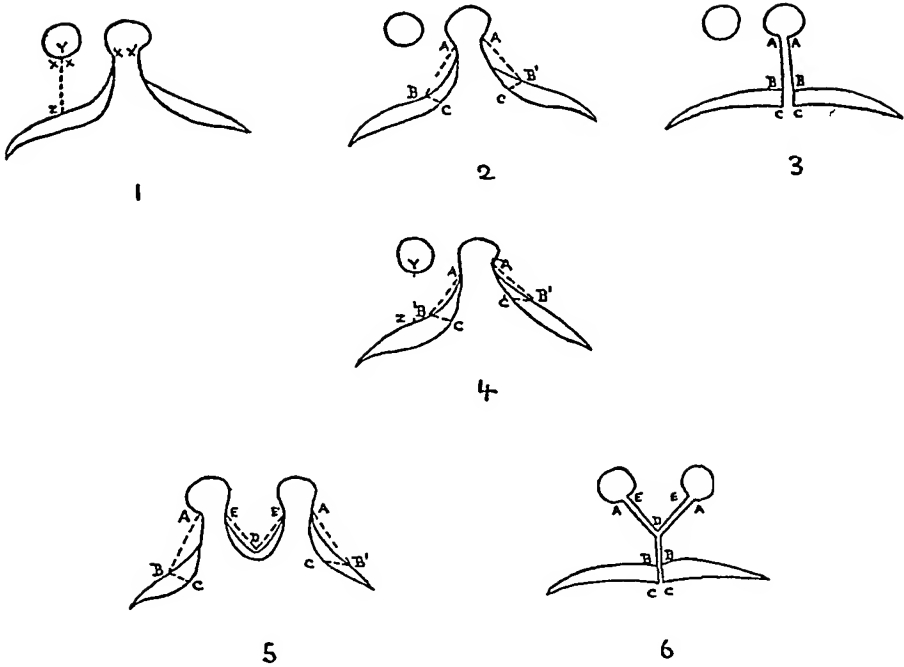


FIG 5—The numbers 1 2 3 and 4 illustrate the method employed in operating on single hare-lip. The measurement YZ in No 1 determines the depth of the lip. In planning the incision the point A is placed on the margin of the nostril B is at the mucocutaneous junction and C is on the free margin of the lip. A' B' and C' are similar points on the opposite side of the cleft. The distance AB is made equal to YZ. The distance BC is a little greater than the shortest depth of the mucocutaneous margin. The distance $AB = A'B'$ and $BC = B'C'$. No 3 shows the result when the edges of the incision are brought together preparatory to suture. No 4 is an example of a cleft with widely divergent sides and irregular depth of mucocutaneous margin. It brings out the irregular direction of the incisions required to secure accurate coaptation. In the numbers 5 and 6 the steps of the operation used in double hare lip are shown. The diagrams are self-explanatory. The distance AB which determines the depth of the lip is more or less arbitrary. It is usually obtained by drawing a line across the cleft with a probe bent to represent the repaired lip and dropping a perpendicular to this line from the coapted margins of the nostril A and E.

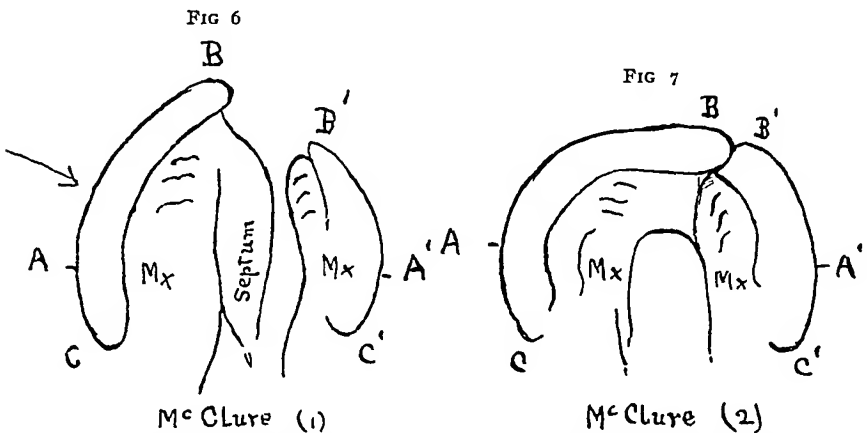


FIG 6—Life sized tracing of a plaster mold of a case of complete unilateral hare-lip cleft of the alveolar border and complete cleft of the palate. The lettering is identical with that used in Fig 1. The arrow represents the direction of pressure in molding the maxilla.

FIG 7—Same case as Fig 6. Tracing of a mold taken some months after repair of the lip alveolar border and anterior part of the palate.

OPERATIONS FOR HARE-LIP AND CLEFT PALATE

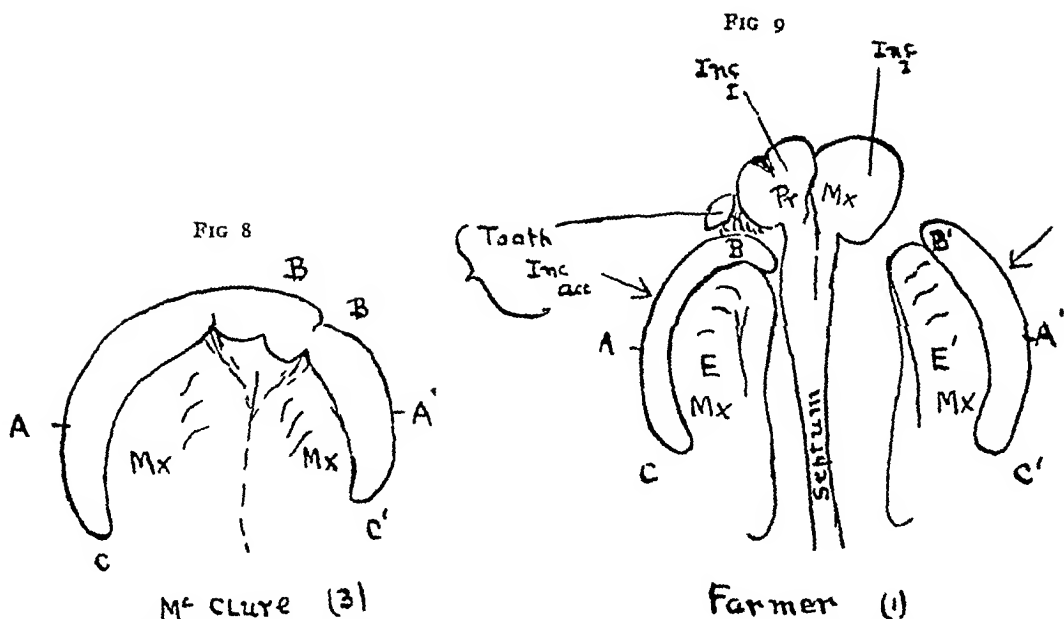


FIG 8—Same case as Fig 6. Tracing of a mold of complete palate. The alveolar borders stand out in relief and the line of palatal union is well shown. The uvula made no impression on the wax mold.

FIG 9—Life sized tracing of a plaster mold of a case of double complete hare-lip, double cleft of the alveolar border and complete cleft of the palate. All the features are described in the text. The arrows show the direction of pressure in molding the maxillae in the first operation.

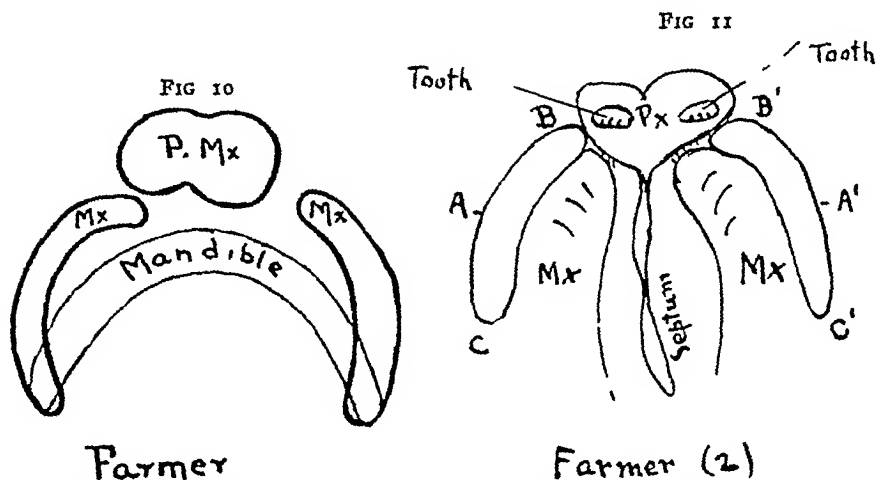
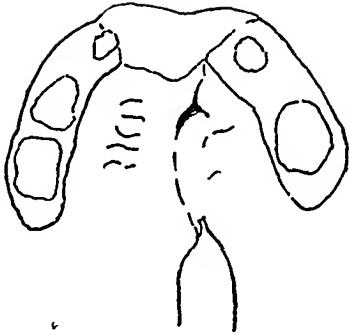
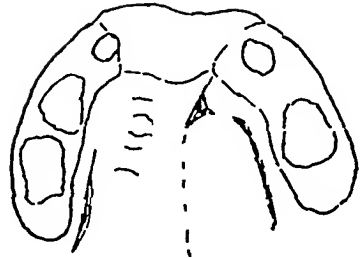


FIG 10—Outline sketch of superimposed alveolar borders of maxillae, premaxillae and mandible of Fig 9, to show their articulation.

FIG 11—Same case as Fig 9, showing a sketch of a mold of the palate taken after the jaws had been molded. This case was taken six months after the operation on the alveolar border.

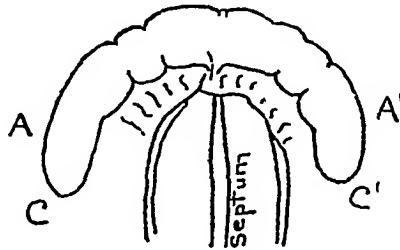


Farmer (3)



Farmer (4)

FIG 12 —Same case as Fig 9 showing sketches of molds of the palate in the various stages of repair. On the left the result of the operation for repair of the anterior part of the palate. On the right the result of a subsequent operation for the repairs of the posterior part of the palate is shown. The steps of these operations are depicted in detail in Fig 23.



Dishman

FIG 13 —Life sized tracing of a plaster mold of a case of complete cleft of the palate associated with intact alveolar margin and lip. Note the very wide cleft with vertical lateral palatal plates. The anterior end of the cleft is very wide and rounded. The septum hangs free.

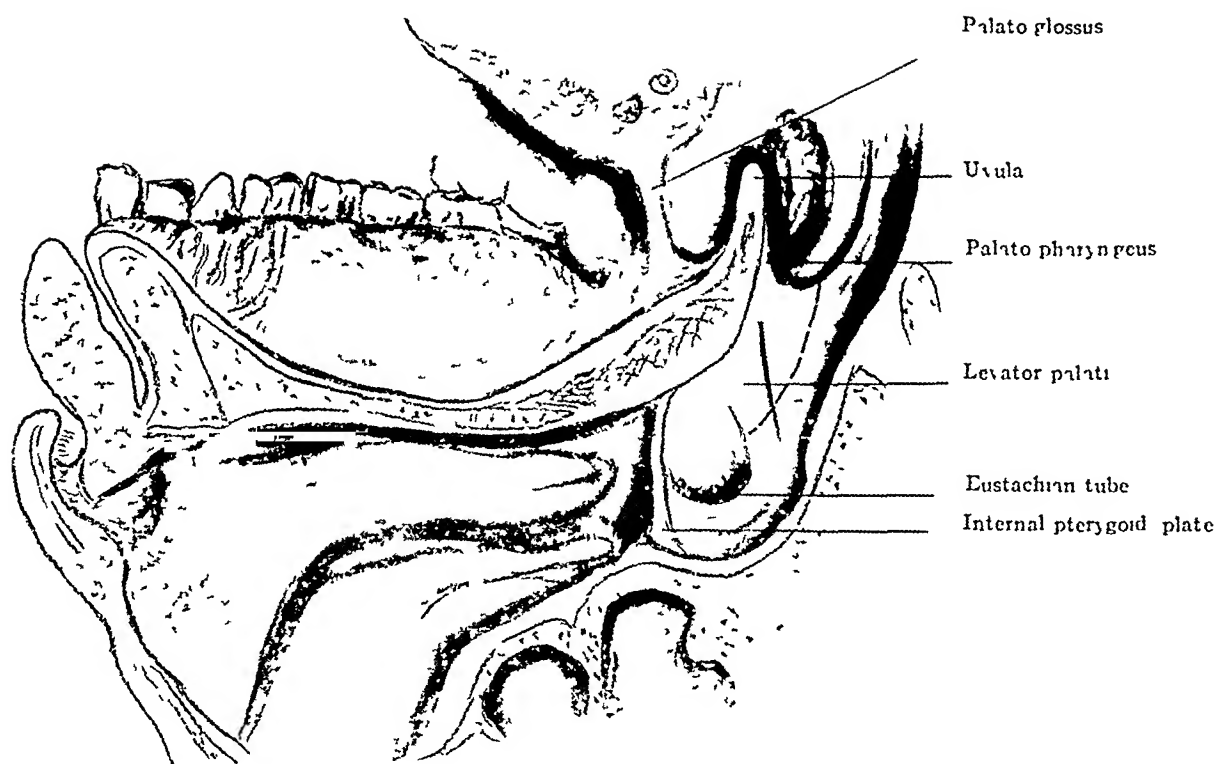


FIG 15 —Original diagram of the soft palate showing the position of the palato-pharyngeus and levator palati muscles The dotted line indicates the position of the incision through the mucous membrane to relieve tension

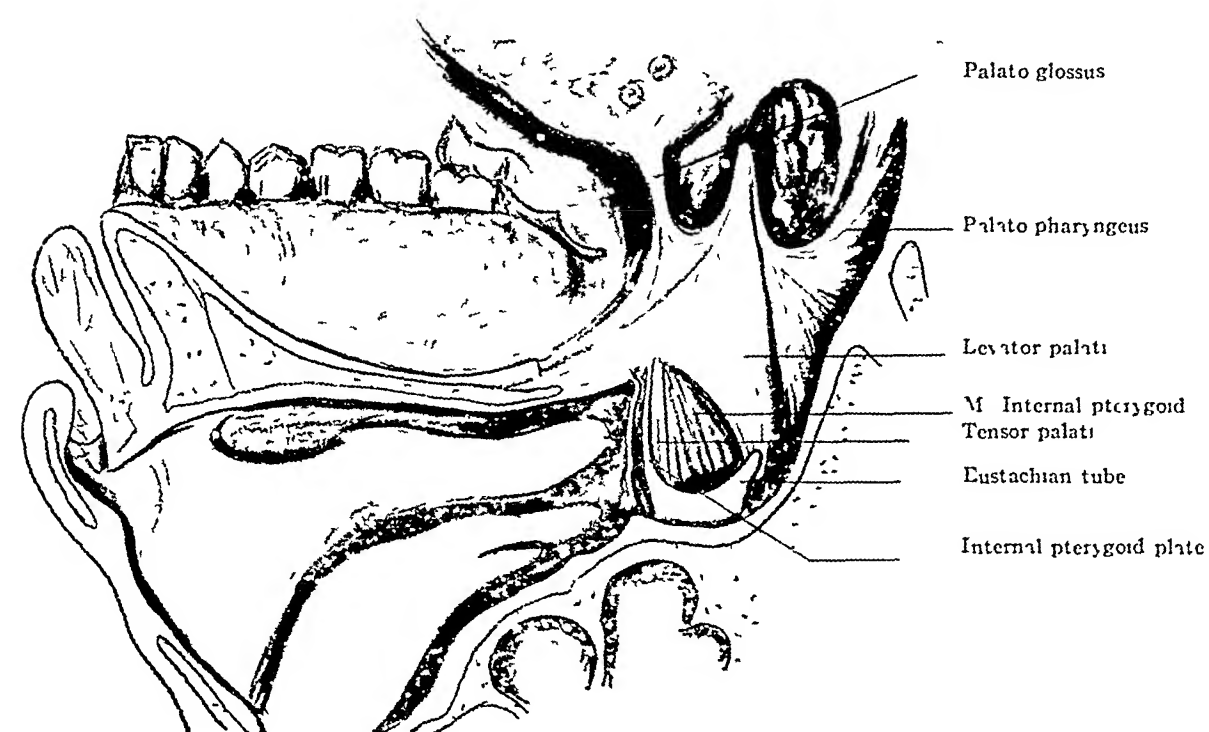


FIG 16 —Dissection of the specimen from which Fig 15 was drawn showing the muscles The labelling of the figure is explanatory

OPERATIONS FOR HARE-LIP AND CLEFT PALATE

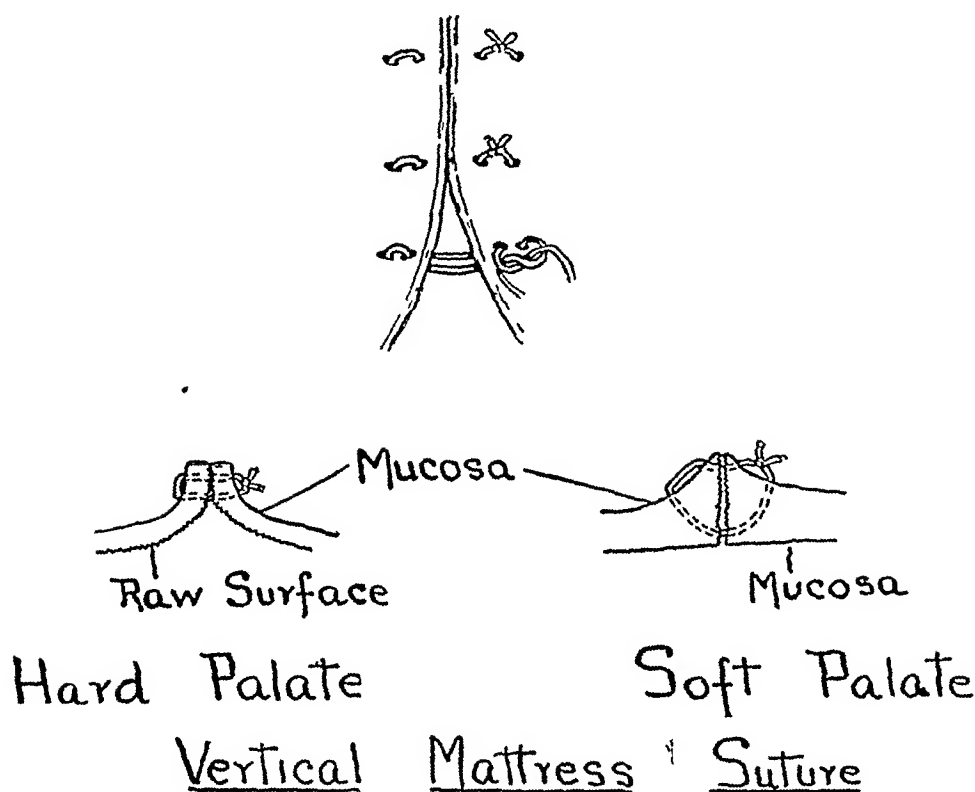


FIG 14 —Shows the method of passing the vertical mattress sutures. In the upper figure the two upper stitches are tied very loosely, the lower one is not tied. It is clear that stitches passed, in this manner cannot strangle the blood supply to the edges of the flaps. In the lower figures, we see cross sections of the stitches tied tight. On the left the raw surfaces of the hard palate are seen to be held firmly together over a large area, and the edges turned out like the flanges of a water main. On the right the stitch is shown passing through mucosa on buccal surface of palate but not penetrating mucosa on cranial surface. This technique is of the greatest value.

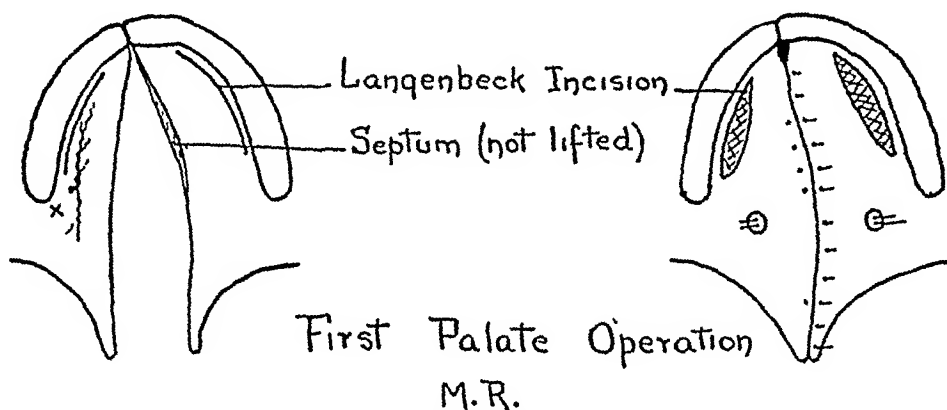
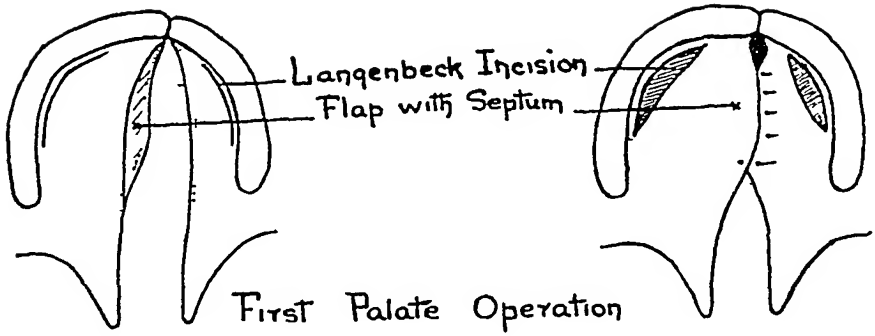
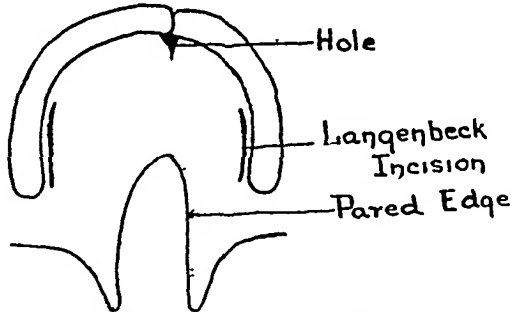


FIG 17 —Sketch of the palate operation in case of M. R. reported in text, repaired from end to end in one operation. This case was reconstructed in two operations. In the first the lip and alveolar border were repaired. In the second the whole palate. Repair was completed at the age of 5 1/2 months. On the left the position of the posterior palatine artery is shown in red coloring. The relation of Langenbeck's liberating side incision to the artery is clearly brought out. It is evident that the incision could be carried backwards around the posterior end of the alveolar process without injuring the artery, if due care were taken to keep close to the alveolus. The cross is on the hamular process. On the right the palate is shown with all the sutures in place. Small metal buttons with wire tension stitches are shown in the velum. In this diagram and most of the subsequent ones the velum is drawn unnecessarily long.



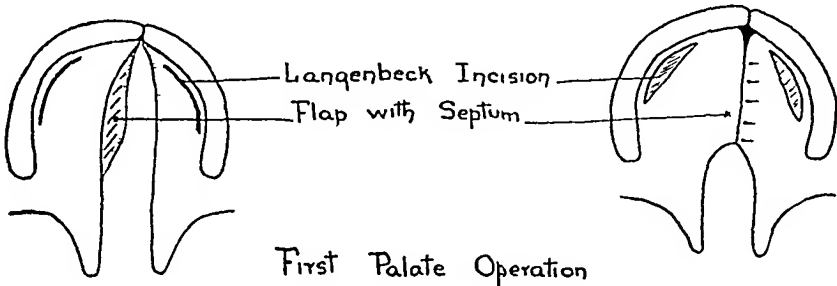
First Palate Operation



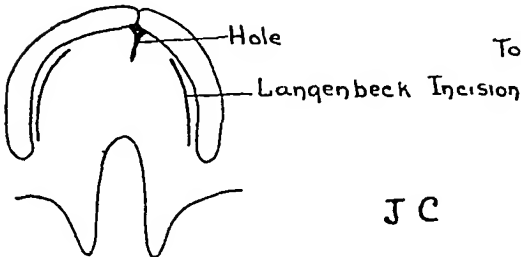
F. C.

Second Palate Operation

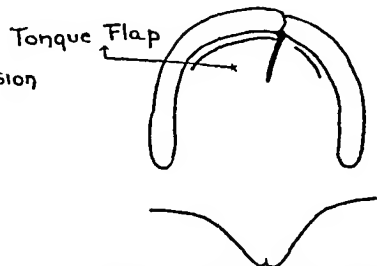
FIG 18 —Palate operations in case F C The first palate operation left a hole in front which is shown much reduced in size at the time of the second operation An almost imperceptible hole still persists



First Palate Operation



Second Palate Operation

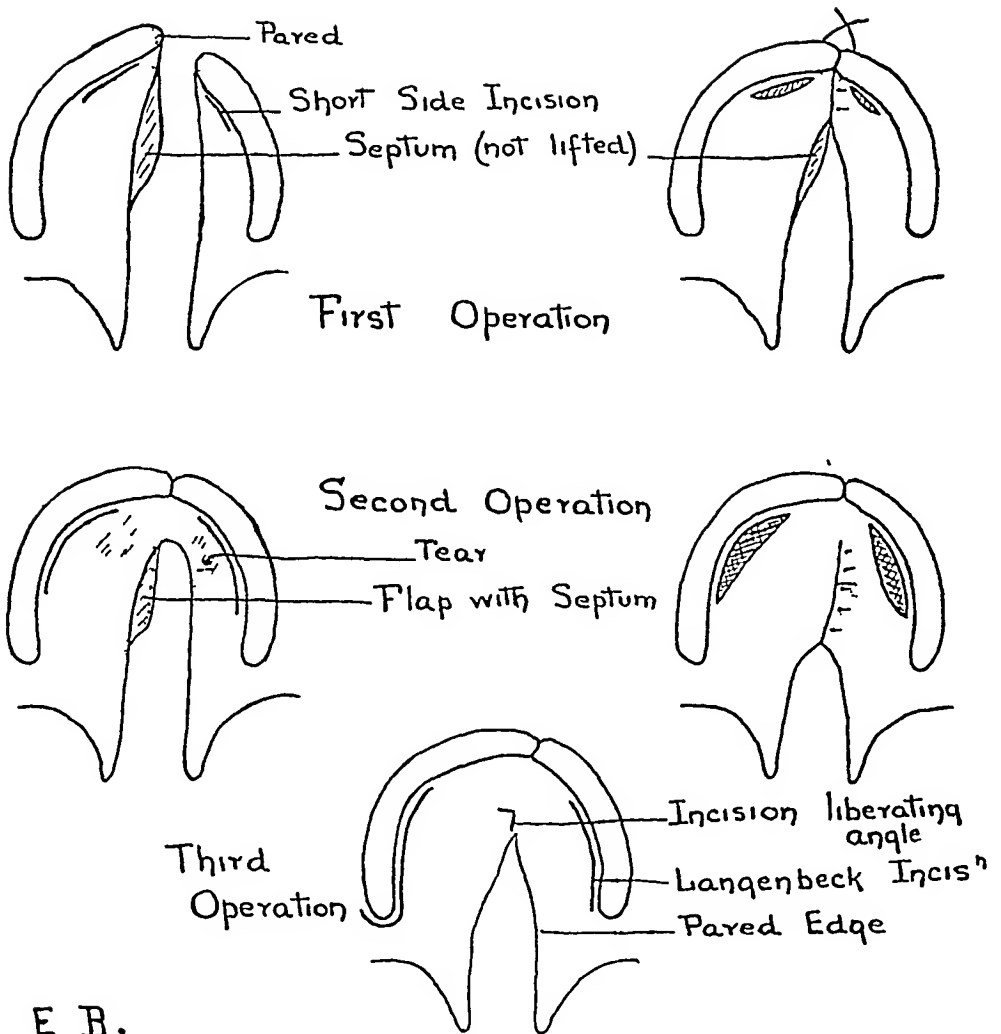


Third Palate Operation

J C

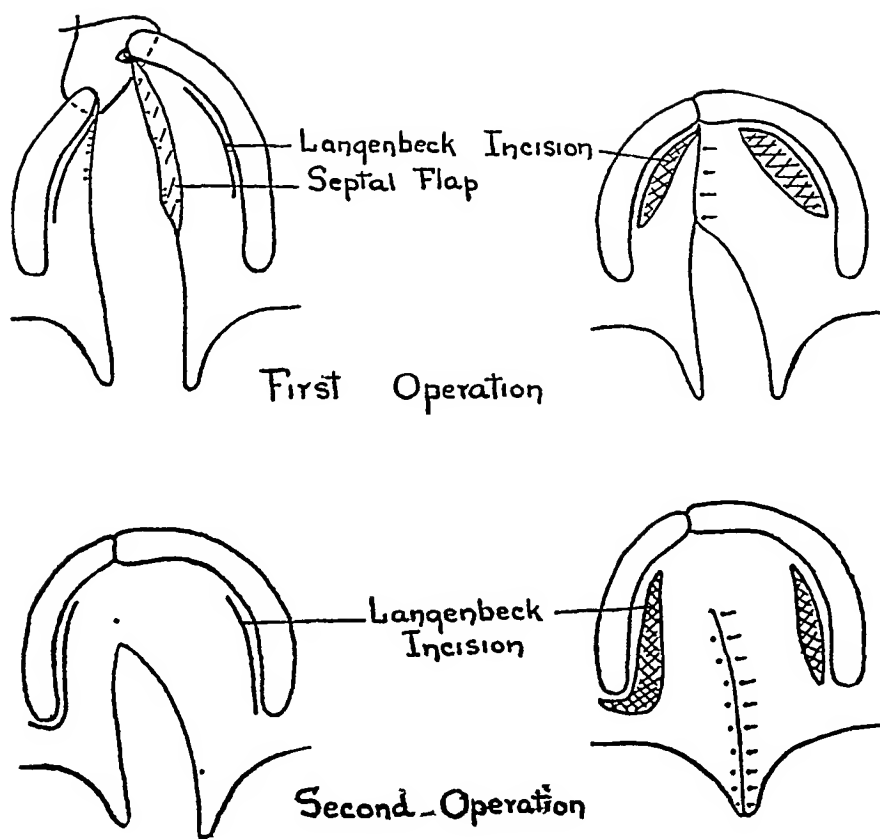
FIG 19 —Palate operations in case J C The first operation left a hole in front No attempt was made to repair this at the second operation when the posterior part of the palate was repaired successfully At the third operation the hole was closed by sliding a tongue flap across the gap from the right side of the palate

OPERATIONS FOR HARE-LIP AND CLEFT PALATE



E B.

FIG 20—Palate operations in case E B. They show repair of the palate in three stages. At the original operation on the lip and alveolar border an attempt was made to close the anterior part of the hard palate by uniting the edges of the mucoperiosteal flap covering the palatal plates. Short Langenbeck's incisions were used. The septal flap was not used. The result was good. At the second operation the remainder of the hard palate only was repaired. A septal flap was used and very short Langenbeck incisions. The left flap sloughed and the result was a failure. At the third operation we employed very extensive Langenbeck's incisions, that on the right was carried in a curve around the end of the alveolar border. At the front end of the cleft we made an L-shaped cut to liberate the angle. The result was a success.



J.H.

FIG. 21.—Palate operations in case J. H. In the case the anterior part of the palate was repaired successfully at the same sitting with the alveolar border and lip (second alternative). The posterior part of the palate was repaired successfully a few months later by using Langenbeck's incisions as shown in figure. Reconstruction was complete at the end of five months.

OPERATIONS FOR HARE-LIP AND CLEFT PALATE

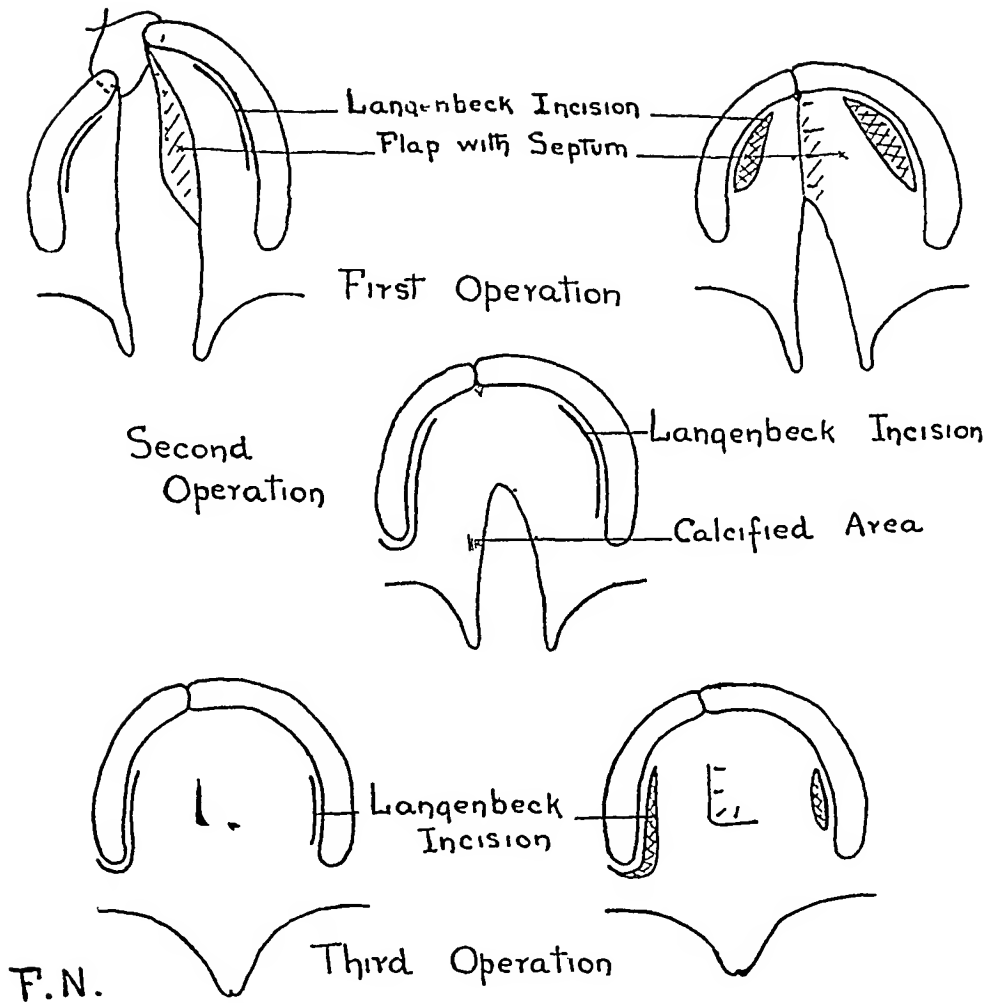
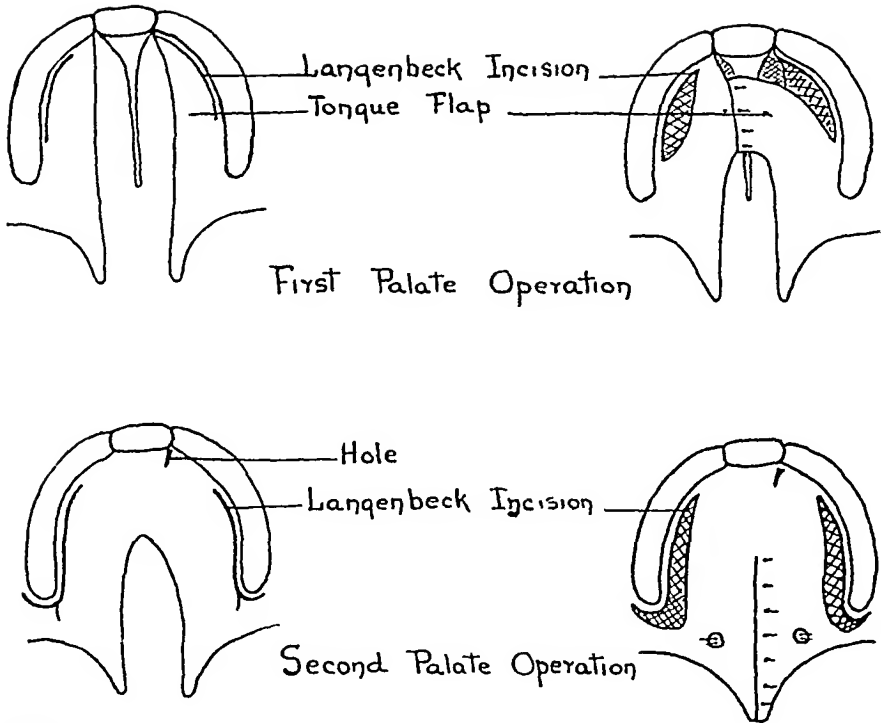


FIG 22 —Palate operations in case F N At the first operation the lip, alveolar border and anterior part of the palate were repaired successfully At the second operation the posterior part of the palate was closed successfully, with the exception of a part in the middle where two small holes were left These were closed subsequently by a plastic procedure shown in the third operation This necessitated extensive liberation of the palate by Langenbeck's side incisions



M F

FIG 23 —Palate operations in case M F This was a case of double hare-lip and complete cleft palate. The anterior part of the palate was closed by a tongue shaped flap Which was lifted up from the left palatal plate brought across the cleft and united with the edges of a flap lifted up by Langenbeck's method from the right palatal plate. The result was a complete success. A very small hole persisted in front. At the second palate operation extensive Langenbeck's incisions were used. Both were curved around the posterior ends of the alveoli and carried backwards towards the base of the tongue. Brophy's tension stitches and metal buttons are shown in the soft palate. The result was a success.

FIG 25



FIG 26



FIGS 25 and 26 — (D G) Case of double hare-lip and complete cleft palate showing result of lip operation described in text. The photograph of the repaired lip shows well formed nostrils and a very satisfactory philtrum well supported by the premaxilla. The lower part of the lip is rather tight and drawn. This will be remedied when teeth appear in the premaxilla.

FIG 27



FIG 28



FIGS 27 and 28 —(E B) Case of single hare lip and complete cleft palate. The photograph taken before operation shows the left flaring flattened nostril and marked deviation of the nose to the right. In the photograph taken ten days after the operation at which time the jaws were molded and alveolar border repaired the nostril is of natural size and the nose is straight. The red line of the lip has been restored and the lip is deep enough. The depression on the left of the line of union on the lip margin is not a notch but is produced by a slight twisting of the lip near the angle of the mouth.

OPERATIONS FOR HARE-LIP AND CLEFT PALATE

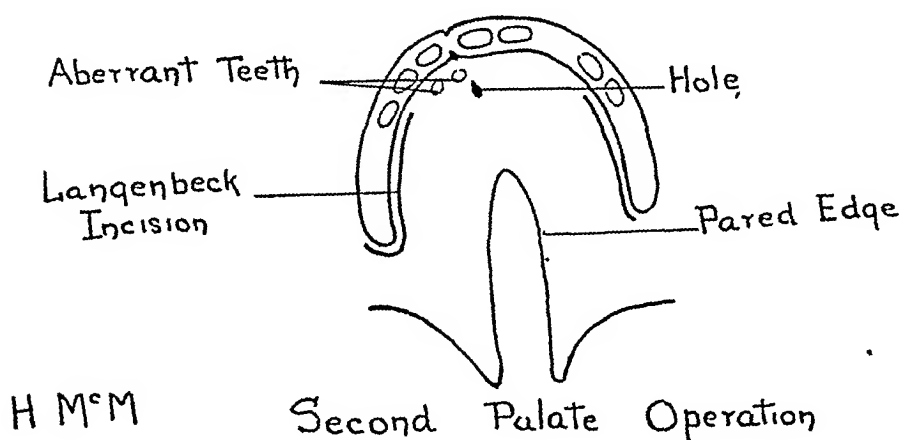
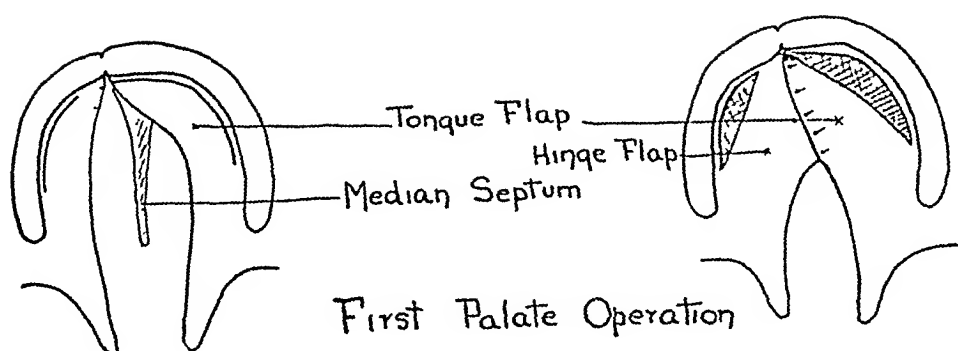


FIG 24 —Palate operations in the case of H McM This was a case of double hare-lip with intact alveolar border The palate and septum are shown in the upper figures of the first palate operation The left maxillary palatal plate and septum had fused The tongue flap was taken from the left side The result was a success At the second operation extensive Langenbeck's incisions were employed, that on the right curving around the posterior end of the alveolar border Result successful

FURTHER DATA CONCERNING THE EXPERIMENTAL PRODUCTION OF PANCREATITIS*

BY EDWARD ARCHIBALD, M D

OF MONTREAL, CANADA

ASSISTED BY

E C GIBBONS, MEd, '23

THE problem of the exact cause of pancreatitis and of the exact mode in which that cause works is still somewhat unclear. As you know, there are three principal theories: according to one the pancreatic lesion is caused by the entrance of bile into the pancreatic duct by reason of an obstruction, either stone, or shred of mucus, or spasm of the common duct sphincter, at the outlet of the common duct; according to the second, which in this country is associated particularly with the name of Deaver, the lesion is caused by an infection traveling from the inflamed gall-bladder along lymphatics to the head of the pancreas, and the third theory is that duodenal contents are forced into the common duct through the papilla, temporarily relaxed, and so into the pancreatic duct. Of these theories the first and the third may be considered as proved for a considerable proportion of the cases reported, at any rate of the acute cases, while the second is still under discussion, and in any event is hardly susceptible of absolute demonstration—it lacks as yet experimental proof, depends upon purely clinical inferences, and goes, on the whole, contrary to the rules of pathology.

It is true that the entrance of duodenal contents has also never been demonstrated by animal experimentation. Nevertheless, the conclusion that pancreatitis is sometimes brought about in this way imposes itself. I refer to cases in which postmortem dissection has shown that the pancreatic duct opened directly upon the mucous surface of the duodenum and not into the common duct, and to one or two rare cases in which there has been demonstrated localized pancreatitis of that part of the organ drained by the small duct of Santorini. These conditions, however, are fulfilled but rarely, and most of our evidence, both clinical and experimental, goes to show that the entrance of bile into the pancreatic duct is by all odds the most frequent mode of causation. This hypothesis has now got outside the bounds of mere theory and is widely accepted as being definitely proved.

I need not in this place recount the history of the clinical and experimental work which has been published in support of this proposition, but shall confine myself to recalling to your minds certain outstanding facts of the experimental work which has engaged my attention for the past few years, and which I presented before this Society two years ago. It was proved that in cats, in which animals the anatomical relationships of the common and the pancreatic ducts resemble those present in the human much more exactly

* Read before the American Surgical Association, June 15, 1921

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than they do in other laboratory animals, it was possible to run a solution from the gall-bladder under a pressure of from 300 to 600 mm of water into the pancreas to such an extent that even the finer radicles between the acini were found filled with the solution. In later experiments it was found possible in the same way to run bile, infected or not, solutions of bile salts, and mucin-free bile, from the gall-bladder into the pancreas with consequent production of various grades of pancreatitis from the least severe up to the acute hemorrhagic form, with death inside an hour. In all these cases the only obstruction possible lay in a resistance of the common duct sphincter.

From a consideration of these experimental facts and of clinical experience it seemed justifiable to present the problem of the etiology of pancreatitis in the following way: "The conditions for actual serious damage to be done in the pancreas must pretty certainly be three: (1) a change in bile composition, increasing the proportion of bile salts, (2) undue resistance, perhaps often amounting to spasm, of the common duct sphincter, and (3) abnormal rise of pressure in the biliary system behind, either in the gall-bladder or in the common duct."¹

"Our problem, therefore, is to discover in the facts of clinical experience circumstances fulfilling these postulates. Here we come on to uncertain ground. It is probable that hyperacidity may have a good deal to do with it. Symptoms indicating hyperacidity are frequently found in the previous history of patients with pancreatitis (Egdahl, 14). Certainly the injection of hydrochloric acid into the duodenum or even into the stomach (Oddi) will cause a spasm of the sphincter. In man we are still unacquainted, so far as I know, with the condition of the duodenal contents as regards the length of time which is necessary for neutralizing the acid chyme of the stomach. In alcoholics, anyhow, and in patients who have duodenal ulcers, it would seem probable that the duodenal contents might remain acid for some time, and in these two classes pancreatitis is rather frequent. One recalls in this connection three cases published by Dr. William J. Mayo, in which acute pancreatitis was present, without gall-stones anywhere, but with, in each instance, a duodenal ulcer situated close to the papilla, presumably causing hyperacidity.

"In the second place, that change in bile which results in a high concentration of bile salts and a diminution of bile mucin is probably brought about by the effect of gall-stones, especially when associated with inflammation. In infected bile, it is pretty certainly not the bacteria acting in their infecting capacity that cause the pancreatic lesion, but rather the chemical change in the bile produced by the action of bacterial growth. This at least was strongly suggested by the work of Flexner, of Carnot, Hlava, and others, and the present experiments, in which sterile bile and a solution of sodium taurocholate caused the lesion equally with infected bile, tend to confirm this view. I am unacquainted with any work upon the chemical composition of infected bile, but it may be presumed that the action of bacteria is to pre-

precipitate the mucin of bile, and indeed we see the evidence of it in the shreds observed in the bile in cases of cholecystitis and cholangitis. If this is the case, it is probable contrary to the assumption of Flexner, that the relative proportion of the bile salts is increased. I may add that Doctor Harding, Associate Professor of Chemistry in McGill University, is beginning work along this line. It must be pointed out, however, that the effect of bacteria upon the bile seems to increase very greatly the destructive effect of that bile upon the pancreas, and while this is still probably due to some chemical change in the bile it seems likely that there come into play, in addition to the bile salts, new substances possessing necrosing properties.

"It may be noted also that any obstruction in the cystic duct would probably deprive the bile of a part of its mucin content normally provided by the gall-bladder mucosa, and in such cases, theoretically at least, the occurrence of a pancreatitis may be rendered more likely.

"In the third place, the condition of increased pressure in the biliary system is presumably brought about partly by an increased resistance of the sphincter, set in motion by hyperacidity or by neighboring ulcers, partly by a sudden blocking of the cystic duct by stone or inflammation, and finally, perhaps, by any unusual increase in the amount of bile secreted by the liver. The effect of a full meal, two or three hours after which, as we see in so many case reports, the attack of pancreatitis is apt to come on, may be in the direction of increased bile production rather than in that of increased pancreatic secretion."

The present work represents a small effort to get deeper into these problems. Fourteen cats have been used. A later report will give details of the experiments performed. Briefly, we have injected ox bile, infected with various organisms, as well as human bile aspirated at operation from acutely inflamed gall-bladders, into the gall-bladder of cats, under pressure, either by running it in from a raised funnel or by squeezing of the gall-bladder. In most, the bile entered the pancreas. We have also injected by syringe direct into the pancreatic substance cat's own bile, human bile from distended inflamed gall-bladders, in one case complicated by very acute pancreatitis, the same human bile several days later running clear and normal-looking from the cholecystostomy tube. We have reopened at intervals, cut out sections of pancreas for microscopical examination, and have taken cultures from the interior of the pancreas often recovering the original organism, thus proving penetration of bile. We have injected HCl into the duodenum to stimulate the sphincter.

Microscopically we have found all grades of pancreatic necrosis of the parenchyma, with much or little stroma reaction, oedema, congestion, hemorrhage, going on after from one to four weeks to advanced replacement fibrosis, local or diffuse. We could follow the development of interstitial pancreatitis, a pancreatic cirrhosis from the original necrosis, through fibroplastic repair.

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The investigation has been directed chiefly along the following lines. In the first place, what effect does infection in bile produce upon the relative proportions of the bile salts and the mucin? Secondly, what difference, if any, exists between the action of infected bile on the pancreatic parenchyma and that of normal bile? Third, is it necessary that an abnormal degree of the force which expels the bile should be present before the pancreatic duct is invaded, and if so, what is the nature of that abnormal force? Finally, under what condition is the common duct sphincter brought into resistance to the flow of bile into the duodenum?

I *The Chemical Examination of Infected Bile*—During the past winter Mr Logan, working in the Chemistry Department of McGill University, under Doctor Harding and Professor MacCallum, has been analyzing, according to the methods of Foster and Hooper, samples of bile which I have brought him from the wards of the Royal Victoria Hospital, together with specimens of bile from the ox, the hog, and the cat. These biles have been variously infected. My idea was that as the result of infection the mucin of bile might be precipitated in such an amount as to leave the bile salts in a much higher proportion, and greater concentration, than in normal bile, and that such a bile being forced into the pancreas would presumably cause a more definite and more severe pancreatitis. Flexner showed that it was the bile salts that caused pancreatic necrosis, while the mucin had a protective action. Our work leaves this supposition as yet unconfirmed. Clinical experience, on the whole, seems to indicate that the more serious cases of pancreatitis are associated with conditions of serious inflammation in the gall passages. Mr Logan's work is still very incomplete. The difficulties of the subject are much greater than the uninitiated might suppose, and I am unable to make any very definite report upon this part of the work. On the one hand, the actual amount of bile salts excreted in the bile varies very greatly according to the nature of the diet, chiefly, but varies anyhow on a mixed diet from day to day (Hooper and Foster). On the other hand, the amount of mucin in a normal fistula bile remains fairly constant. The amount of mucin, when the bile has been infected, shows in some cases a slight increase, in others a slight decrease. The analyses, so far, which have been carried out with several of the ordinary organisms, staphylo- and streptococci and *B. coli*, are insufficient in number to give any sure indication on this point. We expect to carry on the work during the coming year. But for the present it looks as if our hypothesis as to the greater concentration of bile salts as the result of infection remains unsubstantiated. There is probably something else in infected bile which is responsible for the more severe necrosing effect which it shows as compared with normal bile. Upon this point several of the experiments are most positive. One of these in detail is as follows:

Cat 190 Bile aspirated from gall-bladder at operation on a case of acute cholecystitis with impacted stone in cystic duct. The bile was blackish green and was obviously infected. Culture showed a scant growth of streptococcus. The gall-bladder was drained. A portion of

the original infected bile was injected with syringe into the splenic end of a cat's pancreas, and another portion of the drainage bile, which three days after operation had become clear and normal looking, was injected into the duodenal end of the same pancreas. After two days the cat was reopened, and it was found that the infected bile had caused a very marked inflammatory reaction, with fat necroses in the adjoining omentum. In marked contrast with this, the more normal drainage bile had left the duodenal end almost normal. These two areas were cut out and sectioned, and the difference in necrosing effect was confirmed. At the splenic end the necrosis of parenchyma was extensive and there was a great deal of oedema and congestion, while at the duodenal end there was very slight necrosis, little oedema, and practically no congestion.

This observation was confirmed with two other cases of acutely infected bile from cases of acute cholecystitis, and in still another one the same contrast was found between the effects of cholecystitic bile and the cat's own normal bile.

The difference is one of degree. Even normal bile entering the pancreas causes necrosis of the pancreatic parenchyma with which it may happen to come in contact. But this necrosis is aseptic, is accompanied by little, if any, surrounding reaction, whereas the infected bile causes a more massive and extensive necrosis with a great deal of oedema, congestion, even hemorrhage, and with much inflammatory response on the part of the fixed connective tissue. Fat necroses also are often more abundant.

While these results were obtained by the direct injection of bile through a needle, we were able to determine that similar results, and like differences, were found when the bile entered through the pancreatic duct from the gall-bladder. It may here be said that in the present series, as in that of two years ago, in a majority of the experiments in which any pressure was applied from behind, that is on the gall-bladder, the bile entered the pancreatic duct to some extent, as was evidenced by the finding of necrosis. In some instances the effect seemed localized to the central part of the gland nearest the entrance of the pancreatic into the common duct, while in others the bile had invaded the whole gland.

The degree of swelling of the organ was variable. One fact in particular is noteworthy, which was that there might be macroscopically very little evidence of any lesion in the pancreas in the way of swelling or congestion, and yet microscopically necrosis might be quite extensive. In all such cases the bile was practically normal. In other cases, and these the majority, the effect of bile entrance was evident in a definite oedema and swelling, with slight induration of the organ. In these, on microscopical examination, one may find all grades of necrosis, diffuse or localized, involving a few acini or whole lobules, the individual cells showing early stages of degeneration—a diffuse "cooked" appearance, or advanced stages of mass necrosis together with marked oedema and congestion. These observations are, I think, important.

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from the clinical standpoint We are all of us frequently troubled at operation to decide whether the pancreas, which upon palpation we think is somewhat enlarged, a little harder than normal, and nodular, is really the seat of a mild inflammation or is normal The pathologists tell us that in such cases, upon the opportunity of a postmortem, they can find no evidence of pancreatitis, and clinicians of prominence warn us that we should be very chary of saying that there is actual pancreatitis present In two patients, suffering from quite definite subacute pancreatitis, one of my own and one of Doctor Garrow's, a small section has been taken from the pancreas at operation for microscopical examination Let me repeat that the pancreas to palpation was quite certainly enlarged and hard In both the pathologist was of the opinion that there was no clear and definite pathological change present, yet in both I felt justified in concluding that there was clear evidence of pancreatic damage In certain areas the cells were disintegrated, cell membranes broken, nuclei swollen, cytoplasm poorly staining, and in one or two places actually necrotic There was also marked œdema and some congestion I felt sure that these were not artefacts or due to imperfect technic, as the pathologist was inclined to believe, because I had seen the same slight lesions in association with absolutely definite lesions so many times in animals I would, therefore, suggest that at least in many of the cases in which, at operation, we feel that the pancreas is *probably* swollen, it really *is* swollen, and that this effect is due to the entrance of small quantities of bile not seriously infected, and constitutes a warning that the biliary system must be freed of all possible infection

The second part of the problem concerns the question of the *vis a tergo* It is probable that before pancreatitis of any severity can be caused, there must be an increase of pressure in the expelling forces of bile A number of investigators (Doyon, Freese, Mann, Bainbridge and Dale) have investigated the contractile force of the gall-bladder in animals and give figures approximating 150 to 225 mm of water An exact estimation is difficult, and they were concerned only with the normal animal It is probable that in the human, and under pathological conditions, the contracting force of the gall-bladder may be much increased Dr F N G Starr reports the following very remarkable observation During operation on a patient suffering from cholecystitis with stones, under very light anæsthesia, he inserted his finger into the neck of the gall-bladder and immediately found it grasped apparently by a very strong muscular contraction, so strong that, as he puts it, he would have pulled the whole liver out if he had exerted his strength to pull his finger out It was apparently a severe reflex spasm in the semiconscious patient It may be that, if we were not accustomed to operating under full ether anæsthesia, we might encounter the same experience upon occasion In any case this observation seems to me to have a direct bearing on the question If, as the result of the stimulus of stone and inflammation, the gall-bladder is able to contract violently, we are immediately provided with the driving force needed to push bile into the pancreas In my experiments

it has been, as a rule, necessary to fill the gall-bladder more or less rapidly under pressure, or to give it a few squeezes, in order to stimulate the sphincter to contract and offer the requisite resistance. The normal contraction of the gall-bladder is undoubtedly feeble, and, according to Meltzer's law, the sphincter presumably relaxes at the same moment, so that ordinarily bile is not forced into the pancreas.

Another observation, which I owe to Doctor Mann, is that upon any sudden descent of the diaphragm with fixation of the abdominal walls, as in sneezing or vomiting, the pressure in the gall-bladder is driven up to a great height. This also might have some bearing on the question.

In three animals I have tried the effect of eserine hypodermically, and of barium chloride painted on the surface of the gall-bladder. In no case did I observe any peristaltic movement in the gall-bladder wall, although with a very high dose of eserine there seemed to be a slight tonic contraction of the gall-bladder as a whole.

With regard to the third factor, the abnormal resistance of the common duct sphincter, I have nothing new to add. One thing seems definite, that acid in the first and second portions of the duodenum will cause a temporary spasm of the sphincter. The contents of the duodenum have in the last few years been frequently examined since the use of Einhorn's tube has become general, and I understand from Doctor Einhorn (verbal communication) that sometimes he has found the duodenal contents to remain acid for a certain time. Whether one should, in cases of duodenal ulcer, or of the gastroduodenitis of the alcoholic, expect such a condition to be frequently present I do not know, but at least such an assumption is not unlikely, and in that case one might expect a recurring spasm of the sphincter, and this might serve to explain the frequency of pancreatitis in association with ulcer and alcoholism. This must still remain a matter of speculation. In any case, so far as my experiments go, it would seem that the more important factor in stimulating the sphincter to resistance lies in a sudden rise of pressure from the gall-bladder side, rather than in irritation from the duodenal side, and in this connection I am inclined to believe that the reason why a cholecystectomy is apt to cure coincident pancreatitis, lies partly in the fact that the only serious muscular contractile force in the biliary system has been cut out, and partly, also, in the fact that with the removal of the gall-bladder there is also removed the source of infected bile, at least in most cases.

SUMMARY

1. Infected bile, aspirated from the inflamed gall-bladder, exercises a much more severe necrosing and inflammatory effect upon the pancreas than does normal bile.

2. Chemical investigation of infected bile has not yet proved that this difference of effect is due to an increase in concentration of the bile salts as the result of bacterial action on the bile.

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3 Mild grades of pancreatic swelling, as estimated clinically, are certainly possible, and are represented by œdema with early necrosis of the parenchyma, presumably the result of bile invasion. The clinical statement in operation records as to the presence of "a somewhat thickened and indurated pancreas" is probably a correct interpretation of fact in most instances.

4 The gall-bladder, under conditions of irritation from stone or inflammation, is probably able to go into strong muscular contraction, and the hypothesis is set up that such contractions may provide sufficient driving force to cause invasion of the pancreas with bile.

5 The common duct sphincter is provoked to resistance not only by an acidity of the duodenal contents, but also by a sudden distention of the common duct through abnormal and unexpected rises of pressure in the gall-bladder.

¹Archibald: Experimental Pancreatitis, etc., Surgery, Gynecology and Obstetrics, June, 1919.

DRAINAGE OF ABSCESS OF PANCREAS*

BY ALBERT J OCHSNER, M D

OF CHICAGO

THE object of this paper is to direct attention to a very simple and safe method of draining an abscess located in the tail of the pancreas. The history of the case in the management of which this form of treatment suggested itself is not of sufficient interest to warrant its publication in full.

A woman, forty-eight years old, with symptoms of ulcer of the greater curvature of the stomach, which later proved to be malignant, was subjected to an exploratory laparotomy which demonstrated an indurated mass 5 cm in diameter in the posterior wall of the stomach attached to the tail of the pancreas, which was swollen to the size of an orange, about 10 cm in diameter. This swelling was congested and contained fluid. Evidently an abscess had formed in the tail of the pancreas from an infection originating in the perforated gastric ulcer.

In order to determine the condition more perfectly, an opening was torn in the transverse mesocolon and the abscess was found strongly adherent to the posterior wall of the stomach while the posterior wall of the pancreas was quite free. Great care was exercised in the manipulation of the pancreas not to rupture the abscess. An incision was then made in the left flank, immediately below the last rib, 5 cm long, and a pair of forceps passed forward, guided by one hand, in the abdominal cavity to a point behind the pancreas. The blades of the forceps were spread widely open in order to establish a broad passage. The space behind the pancreas was then loosely packed with gauze, in the middle of which was placed a large rubber drainage tube. The gauze and the drainage tube were passed out of the wound in the flank and two cigarette drains were added and carefully placed behind the pancreas. The tear in the mesocolon was then repaired and the abdominal wound was closed. Five days after the operation the abscess broke spontaneously and a large amount of thick pus escaped. The gauze and the cigarette drains were removed gradually. The rubber tube was left in place for two weeks, when the discharge had been greatly reduced. The tube was then removed and the wound healed in two more weeks.

In case the abscess had not opened spontaneously it could have been opened safely after adhesions had been formed around the gauze tampon by passing long dressing forceps through the large drainage tube into the abscess, when the tube could have been pushed forward into the cavity of the abscess. The method is so simple and safe that it seems worth bearing in mind.

* Read before the American Surgical Association, June 15, 1921

TRAUMATIC PANCREATITIS*

By H BEECKMAN DELATOUR, M D

OF BROOKLYN, NEW YORK

ABDOMINAL traumatisms are accompanied by injury to the pancreas in only a very small proportion of cases. Stuart (*Northwest Medicine*, March, 1921) gives a review of the literature to date with a bibliography of fifty-four cases, including one of his own. This list does not contain cases of perforating wounds in which the pancreas was involved. It is probable that the reported cases do not include all in which the pancreas was involved. Some have either not been reported or have not been recognized.

In thirty years continuous hospital experience in two hospitals, where the daily number of severe accidents is large, the case here reported is the first in which we have observed injury to the pancreas.

In some of the more severe cases of abdominal injury in which death followed in a few hours and neither operation nor autopsy was performed, pancreatic injury may have been present. In the cases subjected to operation involvement of the pancreas was not observed and in the non-operated cases the symptoms were not suggestive of this condition.

Penetrating abdominal wounds are not frequently accompanied by injury of the pancreas, according to published statistics. Surgeon General Wallace (*Lancet*, 1917) gives only five cases of injury of the pancreas in a total of 965 penetrating abdominal wounds reported, and in 300 cases collected by Fraser and Drummond (*British Medical Journal*, March, 1917) only one involved the pancreas. The following record gives the details of the one case which has come under my observation.

CASE—*Subcutaneous Laceration of Head of Pancreas*. Operation, Pancreatic-pseudo-cyst operation, recovery. C. S., school boy, aged thirteen years, was admitted to St. John's Hospital, Brooklyn, November 21, 1919, at 1.20 P. M. He had been knocked down by a wagon, the rear wheel of which passed diagonally over the body from the right thigh upwards and to the left across the body to the lower left ribs. There was moderate shock and complaint of pain in the upper right thigh and also in the epigastric region.

He was a well-developed boy, with slight skin abrasion at the upper part of right thigh and slight ecchymosis across the abdomen. There was no distention of the abdomen, no muscular rigidity, moderate tenderness on pressure in epigastric region. No dullness in either flank. Both testicles were drawn up into the inguinal canal. No symptoms of internal hemorrhage. Symptoms of shock slight. Urine analysis negative—no blood present.

Just after admission he vomited a large amount of undigested food, following this pain was much relieved. Temperature, 98.6° F, pulse, 80, respiration, 30.

During the first twelve hours the patient complained at intervals of severe pain. Vomited a bile-stained fluid at frequent intervals. After each attack of vomiting pain would disappear. During first eighteen hours, hourly records gave

* Read before the American Surgical Association, June 15, 1921.

pulse 92 to 96, temperature, 99° F, and respirations, 32 During this period the only symptoms of note were the persistent vomiting and recurrent attacks of quite severe pain The question of internal injury was carefully considered, but with so little shock and no evidence of hemorrhage, it was considered best to carefully watch the symptoms before making an exploration

The following morning the patient was seen by me At this time there was no abdominal distention, moderate rigidity of the recti above the umbilicus and tenderness in epigastrium At this time there was evidence of fluid in the abdominal cavity Temperature, 100.5° Pulse, 100 Vomiting still continued at short intervals It was evident that there was some abdominal injury A tentative diagnosis was made of either rupture of the liver with moderate hemorrhage or contusion or laceration of the mesentery with hemorrhage

Operation twenty-four hours after receipt of injury Incision to right of median line in upper abdomen On incision of the peritoneum there was an escape of considerable blood-stained fluid and a few blood clots There was no evident injury to small or large intestine, spleen or liver In the region of the duodenum the entire area was very cedematous and blood stained On further exploration the head and about one-half of the remainder of the pancreas was found lacerated and contused The pancreas was exposed through the lesser omentum and three iodoform cigarette drains carried down to the injured tissue The drains were brought out through the original incision and the wound closed in layers During the exploration very extensive areas of fat necrosis were observed in the omentum

Although the operation was not a prolonged one and there was no excessive bleeding, the shock following was very marked The pulse became 136-150 and very weak, and so continued for twenty-four hours The temperature the first night reached 103° F, and the following noon 103.8° F, pulse 130, and respirations 40 There was extreme restlessness and thirst A profuse sanguinous discharge from the drains was extremely irritating to the skin

November 24th Much less restlessness and thirst has disappeared Abdomen slightly distended, moderate amount of pain and no vomiting since operation

November 26th Temperature 99.8° F, pulse 100 General condition good Has vomited once, milk stained with bile

November 29th Has been complaining of hunger Given soft diet, which was taken with relish Normal bowel movement Temperature 99°, pulse 80 Iodoform drains removed Much irritation of skin about wound

December 3rd Very little discharge, all drains removed Complains of pains in epigastrium, especially at night Is very restless and vomited greenish fluid during the day

December 9th During the past days has complained a good deal of pains in the epigastrium, especially at night, and after eating Abdomen slightly distended, particularly in the epigastrium Enema given with satisfactory result, but without relief of pain Has vomited at intervals Is very irritable and restless

December 10th Temperature suddenly rose to 102.4° F, patient was very restless and vomited twice during the day No local abdominal findings Partial obstruction of bowels by adhesions was suspected

December 23rd Since last note there has been some improvement in the general condition, vomiting only occasionally, and pain usually quite severe each night Has been out of bed part of each day during the past week Has felt better and is hungry There have been occasional attacks of abdominal pain, but not as severe Has vomited only once or twice Today, following an attack of intense abdominal pain, the temperature suddenly went to 102.6° F There was some abdominal distention and tenderness over pancreatic region

TRAUMATIC PANCREATITIS

January 4, 1920 Since last note the temperature has continued between 99° and 101°. He has been very comfortable during the day, but during the nights has had severe attacks of pain that cause him to cry out. During the past two days a swelling has been evident in the epigastric region and has enlarged rapidly. Blood count leucocytes, 27,000, polymorph 85 per cent. Vomited a large quantity of dark green fluid once each day for three days.

January 5th Leucocytes, 21,000. Mass in upper abdomen much larger. Pains still continue. Diagnosis of pancreatic cyst made and operation advised.

January 6th Incision made in back just below twelfth rib, two inches to the right of spine. Through this the posterior abdominal wall was opened and the mass was found just internal to the upper pole of the kidney. This was incised and about three pints of clear fluid evacuated. A drainage tube was inserted and the wound closed about it.

January 8th. Patient's condition improved immediately after the operation. Pain and vomiting have ceased. There has been a profuse discharge through the drainage tube.

January 19th Marked improvement in general condition, discharge continues. Tube removed.

January 23rd Out of bed. No further drainage. There has been a marked increase in weight during the past week.

February 6th Discharged from hospital.

May 1, 1921 General health has continued to improve. There has been no recurrence of the symptoms.

The points to be noted in this case are

- 1 The comparative absence of shock, although over one-half of the pancreas was badly contused and lacerated.

- 2 The principal symptoms, both during the first hours after the injury and during the stage of development of the cyst, were vomiting and severe upper abdominal pain occurring at intervals. In each instance these were immediately relieved by operation. Emaciation was marked until after the cyst was drained, although the boy was eating well most of the time.

- 3 The ease of approach from behind and the better drainage obtained.

Stuart, in his paper, reports a case of subcutaneous injury to the pancreas due to a direct blow on the upper abdomen. In this case dyspnoea was a very marked symptom. Persistent vomiting and pain were also present.

R. A. Stoney (*British Medical Journal*, April 13, 1918) reports a case of pancreatic pseudo-cyst following a shell wound of the abdomen ten months before. Complete recovery after drainage.

Morley (*British Medical Journal*, March, 1918) reports the case of a private hit in the back by shell fragment July 24, 1916. There was no evidence of peritonitis, but severe aching pain in the epigastrium. Two weeks later a swelling appeared in the epigastrium with rapid loss of flesh. Temperature, 99.4° F, pulse, 100. Three weeks after injury operation was performed through an anterior incision exposing a fluctuating tumor in the lesser sac. The anterior wound was closed and the cyst opened by an incision from behind below the twelfth rib on the left. About four pints of clear fluid evacuated. Recovery slow.

C. A. Roeder (*Nebraska Medical Journal*, January, 1920) states that in

forty-seven cases of pancreatic cyst twenty per cent gave a history of abdominal trauma

The pancreas is occasionally injured during operation on other organs While performing pylorotomy a portion of the pancreas may be removed in making a wide dissection I have had two such cases without any harmful result

Young (*Journal of Urology*, 1917) reports two cases of injury to the pancreas during nephrectomy He states this is more liable to happen on the right side because the head of the pancreas is more fixed and approaches nearer the suprarenal body In one case death occurred on the fourth day and autopsy showed fat necrosis and acute pancreatitis This was evidently due to the application of a clamp to secure bleeding at the bottom of the wound Young says we should suspect such a condition where the operation is followed by rapid prostration and extreme distention

Stuart, in his review of cases of subcutaneous injury to the pancreas, cites forty-six cases in which the results are known, thirty-eight were operated, out of these twenty-seven recovered and twelve died In several of the reported cases where operation has been performed the stomach has been described as being pressed forward and spread out over the cystic tumor In each of these cases had aspiration been resorted to the needle would have passed completely through the stomach before entering the cyst Aspiration should never be employed in tumors of the upper abdomen

In conclusion, we would direct attention to the posterior incision as being the simplest and most direct method of reaching and draining cysts or abscesses of the pancreas If the diagnosis is not made before exploration then as soon as the condition is clear it is better to close the anterior incision and approach the tumor through an incision parallel to the lower border of the twelfth rib of the side on which the tumor is most prominent

CHRONIC CHOLECYSTITIS WITHOUT STONES DIAGNOSIS AND TREATMENT*

BY WILLY MEYER, M D
OF NEW YORK

SINCE patients with affections of the bile tract have become borderland cases, the operating surgeon has often been disappointed, when cutting down in the quiescent stage of the trouble upon the gall-bladder of a patient who had gone through a number of colicky attacks in the right side of the upper abdomen, to find a seemingly normal, soft, bluish and glistening organ, not harboring stones, nor presenting any adhesions whatever

No doubt many a surgeon, knowing and finding stomach and duodenum not to be the seat of the trouble, even to-day reluctantly removes the appendix in such a contingency and then, leaving the other organs intact, closes the abdomen, or, if the appendix had been removed at a previous operation, he considers the present interference a disappointing exploration and desists from further investigation

But the patient does not get well

Had, in a case like this, a more detailed examination been made, had *all* the diagnostic means which are at our disposal to-day, been exhausted previous to the operative interference, the probabilities are that they would have given an indication for a procedure that would have been helpful to the patient

I *Diagnosis*—On trying to analyze a patient's complaints of frequently recurring, or more permanent, pain in the upper abdomen, the physician whose advice is sought, will primarily think of disease of the stomach, duodenum, gall-bladder, or pancreas, secondarily also of the appendix and kidney

A most carefully taken and minutely exhaustive history of the case and an equally thorough clinical examination will pave the way for a preliminary diagnosis. For an intelligent differentiation the laboratory then has to step in

Determination of the quantitative and qualitative acidity of the gastric contents, string test with the use of the duodenal bucket, examination of the fæces, Wassermann test and radiography with fluoroscopy will usually enable us to determine the presence or absence of gastric or duodenal affection

Local tenderness and retention of part of the bismuth or barium meal at the end of twenty-four hours within the appendix, as shown by the X-rays, point to an affection of this organ. Its definite inclusion or exclusion in the diagnosis has gradually become of less importance in complicated troubles, since the majority of surgeons nowadays remove the organ in every

* Read before the American Surgical Association, June 15, 1921

case of abdominal incision, except the general condition of the patient forbids this addition, or adhesions bind the appendix down so firmly that it cannot be pulled into the wound. Even then, many of us, in order to take advantage of the anæsthesia, quickly add a special incision in the right lower quadrant, and thus free the patient once for all from the possibility of appendicular disease.

The history, repeated urinary analysis, stereoscopic X-ray picture and, if indicated, cystoscopy with ureteral catheterization and pyelography will usually clear up the question as to the presence of surgical renal disease, particularly of a stone, in the greatest number of cases.

In the course of the last years the diagnosis of pancreatic affection has been greatly refined by the examination of the duodenal contents. If all three ferments, amylase, steapsin and trypsin are found, and in sufficient quantities, serious pathologic changes can be excluded.

For the determination of the presence of gall-bladder disease by means of laboratory findings, radiography, cholesterol test of the blood and examination of the duodenal contents with the help of the microscope as well as by chemical analysis and bacteriological culturing are at our disposal to-day.

Radiography—At the last meeting of the American Gastro-enterological Association, at Atlantic City, May 3 and 4, 1920, A. W. George, of Boston, created quite a stir by maintaining that the healthy gall-bladder does not show on the plate under ordinary conditions, therefore, if the X-rays demonstrate a distinct outline of the gall-bladder, without showing the presence of gall-stones, such a gall-bladder is to be considered pathologic. He believed that this test may be relied upon in about 90 per cent. of the cases.

This claim, if correct, would mean a valuable addition to our diagnostic capabilities as regards chronic cholecystitis without stones. In view of the importance of this matter, from a clinical point of view, I took occasion recently to obtain the opinion of five of the leading radiologists of New York City as well as of two not residing in New York, and the present attitude of Doctor George himself. I requested their answer to the following questions:

1 Does the visualization of the gall-bladder on an X-ray plate mean a pathologic condition of the viscus?

2 In what percentage of cases do you think radiology able, at the present moment, to visualize stones in the bladder?

A reply was sent by every one, for which I feel most grateful.

Looking the letters over with regard to question 1, it appears that of the eight specialists interrogated, three answered with a definite "yes", three appear to lean toward answering the question in the affirmative, one replied "no", one leans toward answering the question in the negative.

With reference to question 2, one considers it of relatively slight importance, compared with question 1, he is inclined to "put the diagram of the adjacent hollow viscera first, a visualized gall-bladder, particularly if altered in shape and density, second, and the direct detection of gall-stones, either positive or negative shadows, third. If all three of these are present, or even

the first and second are present, he believes the X-ray diagnosis relatively certain "

One says "the demonstration of gall-stones depends chiefly on their amount of contained calcium There are many ways of figuring percentages, but we are able to demonstrate only a small minority of gall-stones definitely and diagnostically " He adds as his belief "that in diagnosing disease either of the gall-bladder or appendix, the chief value of the X-ray is in excluding disease of the alimentary canal and genito-urinary tract "

One estimates the cases of gall-stones which are of sufficient density to produce characteristic shadows on the X-ray plate, under 25 per cent , one, 32 per cent , two, 50 to 60 per cent , one, 85 to 90 per cent , one believes that visualization depends on the thickness of the patients, so much so that in those who are not extremely heavy practically all stones can be visualized , while he estimates a positive result in very fat patients equals 30 per cent

Hope is expressed by one that pneumoperitoneum can be simplified, which would increase the positive percentage

The conclusion we can draw from the foregoing is that, up to this moment, the assistance which the surgeons hope will be rendered by radiography in the fixation of the diagnosis of cholecystitis without stones, is in its evolution, promising however assurance of great improvement in the near future And with regard to cholelithiasis it appears that at present radiography in the hands of experts may be relied upon as a means of helping to clear up the cases of recurring or permanent pain in the upper abdomen, as far as the gall-bladder carrying stones is concerned, likely in about 30 to 50 per cent of the cases

I said advisedly "pain in the upper abdomen," and not pain in the right upper quadrant, because it is a fact that must be borne in mind that the subjective pain due to a diseased gall-bladder may be exceptionally confined to the left side of the upper abdomen, and may be noticed by the patient over the left costal arch and the left side of the chest only, radiating from there to the left scapular region and shoulder, at no time involving the right side

Since paying strict attention to this phenomenon for the last number of years, I have noted with increasing astonishment how frequently patients, suffering from gall-stones, complain of spontaneous pain in the region of the sigmoid, let us say in McBurney's point on the left, no' seldom also tenderness at this point This observation has been made particularly in emergency cases sent to the hospital with the tentative diagnosis of intestinal obstruction. It is only on closer examination that the surgeon will be able to make out that an inflammation of the gall-bladder is at the bottom of the trouble, that he has to deal with a reflex nerve phenomenon—paralytic ileus—and not an organic obstruction

Cholesterol Test—Regarding the cholesterol test, I have made inquiries from a colleague who, for many years, has done original work along these lines He writes that a blood cholesterol determination when properly interpreted "is of decided value in the diagnosis of cholelithiasis " He adds "as with any test of this sort, it is paramount to realize its limitations "

Other authors think that the cholesterol test of the blood cannot be relied upon in the diagnosis of cholecystitis with stones, to say nothing of cholecystitis without stones

In this uncertainty of laboratory assistance the analysis of the duodenal contents stepped in and has proven one of the greatest advances clinical medicine has made in the course of the last five or six years with reference to determining and segregating diseases of the stomach, duodenum, liver, gall-bladder and pancreas. Einhorn's duodenal tube has carried a bright light into the hitherto existing darkness as regards the more refined diagnosis of diseases of these organs, same as cystoscopy and ureteral catheterization did literally some thirty years ago in connection with diseases of the urinary system. The aspiration, siphoning out and examination of the duodenal contents has pushed the recognition of the pathological conditions of diseases in the upper abdomen—as well as their treatment—a tremendous step forward. It is inspiring to note the increasing interest the subject awakens everywhere, particularly among the younger generation of medical men. There is hardly a man on the house-staff, I fancy, of any one of our larger hospitals, who has not become an expert in handling the duodenal tube and examining the collected fluid, who has not become an ardent disciple and co-worker in the evolution of this fascinating branch of medical and surgical diagnostics.

At the present moment physicians and surgeons are busy trying to determine the best and most useful and reliable method of collecting the duodenal contents.

When Einhorn and I commenced our combined work along these lines some five or six years ago, Einhorn had used his tube for diagnostic purposes for several years, in fact, he invented the method in 1909¹ for the purpose of diagnosing pancreatic disease. Later on he made use of it also in a therapeutic way, particularly for the treatment of gastric and duodenal ulcer. Since then its scope has been expanded steadily. I will but mention the healing of a duodenal fistula by means of a long duodenal (intestinal) tube (five cases on record so far), the use of the intestinal tube in diseases of the lower intestinal tract, duodenal flushing in the treatment of the so-called thrombo-angitis obliterans and other cases of tobacco-smoke poisoning—duodenal feeding in operations on the mouth, pharynx, throat, œsophagus, etc.

Regarding the collection of the duodenal contents, we consider it best to do it with the patient in the fasting condition. Einhorn's results of the examination of the contents thus obtained, covering a period of eleven years,² prove its advantages. With regard to the bacteriological examination of the contents Garbat has corroborated Einhorn's findings with regard to the best method of collection in every respect.³ With the metal tip of the tube twenty-six to twenty-eight inches (about 66 to 71 cm.) from the incisor teeth, the duodenal contents are aspirated early on the morning following the introduction of the tube. It is to be assumed that liver as well as gall-bladder—provided the cystic duct is not obstructed—are physiologically discharging

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some of their contents into the duodenum, in spite of the fasting condition. If, exceptionally, no bile is found on aspiration, the injection of a few cubic centimetres of warm saline solution suffices to make it appear. The tip of the tube lies in waiting right in front of or somewhat below the papilla Vateri ready to receive the bile as it is physiologically discharged into the duodenum, suction from without then forces it into the barrel of the syringe. Green, yellow, yellow-green or black-green color and turbidity of the bile, the presence of pus corpuscles, particularly when in clumps, a small number of cholesterol crystals, and frequently numerous bacteria, point, we believe, to cholecystitis without stones, an increase in the quantity of these admixtures, particularly of the cholesterol crystals when they are very big in size and mixed with calcium of bilirubin crystals, to cholecystitis with stones.

If the radiograph and cholesterol-test point in the same direction, such corroboration is, of course, gratifying.

Since the Fall of 1919, particularly since the last meeting of the American Gastro-enterological Association at Atlantic City, May, 1920, the investigations of B. B. Vincent Lyon, of Philadelphia, have been brought more conspicuously before the medical profession. There is, I believe, hardly a centre of medical investigation, hardly a hospital of standing in our States to-day, that is not actively and enthusiastically engaged in collecting and examining the differently colored bile as it is poured out of the common duct through Vater's papilla after the injection of 60 c.c. of a 25 per cent solution of sulphate of magnesium into the duodenum. Lyon was the first to suggest this procedure for the segregation of the bile from the different sources, on basis of Meltzer's theory that a concentrated solution of magnesium sulphate, when injected into the duodenum, would relax Oddi's sphincter and also lead to a contraction and emptying of the gall-bladder in consequence of the physiological law of crossed innervation.

Lyon and his followers interpret the cycle of the changed color of the poured-out bile from dark yellow through black to light, golden yellow, as representing the contents of the common duct, gall-bladder and hepatic duct—bile A, B and C. At the present moment it seems that this interpretation is not tenable. Einhorn's most interesting and convincing clinical and chemical investigations have shown that the dark-green often black bile (the so-called bile B), as caught by continued siphonage by the examining physician, after the injection of the magnesium sulphate solution, *does not represent* the contents of the gall-bladder, but is discharged from the liver. It can also be produced by duodenal introduction of sulphate of sodium, pepton, glucose and some other substances. Moreover, the same phenomenon of the outflow of very dark bile after the injection of these different chemicals, can also be observed in patients whose gall-bladder had been removed previously, thus distinctly showing that the dark bile does not emanate from the gall-bladder. It seems to be a secretion of the liver cells, pressed into increased activity by the absorption of the chemical substances from the duodenum by way of the venous system into the liver proper. Einhorn thinks that the dark color

is probably due to the production of iron through the acute destruction of red blood-corpuscles within the liver cells⁴

A further, clear proof for the contention that the so-called "B-bile" does not represent the contents of the gall-bladder, is rendered by direct clinical observation. The bile, poured out of the common duct after the 25 per cent magnesium sulphate instillation into the duodenum, *always* shows the same dark, brown-black color, whereas the gall-bladder content, if aspirated from the viscus during the operation, prior to cholecystectomy, is not in every instance dark-brown or black, but often green, green-yellow or greenish black, viz, of the same color as ascertained before operation, on collecting the duodenal contents with the patient in the fasting condition.

To repeat, the definite and, as it seems, correct conclusion arrived at by Einhorn is, that the dark bile siphoned from the duodenum with Lyon's test, is not furnished by the gall-bladder alone, but also—if not principally—by the liver. Consequently the proper and advisable procedure for collecting the duodenal contents in order to prove disease of the gall-bladder is, to do so with the patient in the fasting condition, and not after the liver has been artificially whipped into overwork.

As stated above, reliable data for the diagnosis of cholecystitis have been collected in this way, which many times were proven correct by subsequent operation.

II Treatment—As in other diseases of the intraabdominal organs of the borderline class, the treatment may be either symptomatic or radical.

An individual of some means who suffers from chronic cholecystitis and is opposed to or for various reasons prevented from undergoing surgical interference, can visit Carlsbad, Vichy, French Lick or other spas of reputation, drink the waters there, and later at home continue the treatment, following a strict diet, often for life time, and taking care that he has regular bowel movements. Intermittent forced evacuation of the bile from the common duct by means of the instillation of the 25 per cent magnesium sulphate solution through the duodenal tube, and auto-vaccine treatment on basis of direct bacteriological findings and cultures from the collected bile, may further contribute to the patient's well-being in the course of this conservative treatment. He may thus lead a fairly satisfactory existence and be able to hold in check the frequent, tormenting gastric hyperacidity. However, he is never sure of himself, at any moment, suddenly, unexpectedly and unprovokedly a new attack may strike him. And the attacks due to cholecystitis without stones are often just as severe as those due to cholecystitis with stones, being likewise connected with fever, vomiting and general malaise. If such a patient gets tired at last and wants to be cured or at least made as safe and comfortable as possible, the removal of the gall-bladder has to be advised.

A patient in moderate circumstances, afflicted with recurrent cholecystitis, should be differently advised and treated from the start. Knowing that the absence of the gall-bladder is well borne by the human system, cholecystectomy is here clearly indicated. And the advice to have the gall-bladder

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removed, may be given conscientiously and emphatically by the medical man, as it is an almost certain clinical fact, that the chronic cholecystitis without stones very frequently is the precursor of the chronic cholecystitis with stones. Expressed in other words, a certain percentage of these patients will probably pass into the condition of cholelithiasis. In order to make them well, and useful members of family and community, from an economic point of view, cholecystectomy should be advised.

With the examination of the duodenal contents added to the series of required laboratory examinations in every chronic case of abdominal pain, above as well as below the umbilicus, the additional presence of a cholecystitis will often be detected, where appendicitis alone would be diagnosed by those who do not practice the method.

Having recognized a chronic, recurrent gall-bladder inflammation to be present besides a chronic appendicitis, and, perhaps, the principal cause of the symptoms complained of, we do not proceed by the unsatisfactory method, still practised by many, of cutting down upon the appendix and then palpating the gall-bladder, to find out whether or not it contains stones, and if so, remove it only then. With the refined diagnosis before us, it will become our duty to cut down upon the gall-bladder first, and then pull up into the wound the cæcum for the removal of the appendix. In this way we shall be enabled to inspect and palpate incidentally any other organ of the upper as well as lower abdominal cavity. With such preoperative, thorough examination and corresponding operation, a much greater percentage of patients with chronic, recurring abdominal disease will get well with the help of *one* operation, instead of two or more.

Personal work done in this direction and on this basis in conjunction with Doctor Einhorn, for the last five or six years, justifies the following.

III *Summary*⁵—I Aspiration of bile from the living gall-bladder during operation having shown the same stigmata as that collected from the duodenum in the fasting condition, before operation, definite proof has been rendered that the examination of the duodenal contents, obtained by the duodenal tube, with the patient in the fasting condition, deserves confidence and is to be considered a reliable procedure.

It is no hardship for anyone to swallow the tube, with some little persuasion, the most sensitive patients will permit even a repetition of the procedure, should this become necessary.

2 A glistening, bluish, soft and non-adherent gall-bladder found during operation may be diseased and harbor pathologic organisms within its walls.⁶ These organisms leave their place of habitation at times and enter the gall-bladder contents, infecting the bile stored within, although this bile has left the liver and reached the gall-bladder in a sterile condition. Recurrent attacks of inflammation, varying in severity according to the degree of virulence of the bacteria, will be the immediate consequence.

3 The bile within the gall-bladder, though discolored and turbid, is often found sterile. This is explained by the bactericidal action of the bile as

such, and the but occasional presence of active bacteria within the bile. Aspiration of a certain quantity of bile at a given moment during the operation may just strike a sterile fluid, which, at other times, may contain bacteria.⁷

4 In view of the fact that bacteria are frequently found in the centre of gall-stones, we can understand how it happens that cholecystitis without stones is the precursor of cholecystitis with stones.

Cholecystectomy in cases of cholecystitis without stones, therefore, clearly represents a prophylactic operation in many instances, and is of particular benefit to those who must get well in order to be able to earn their living.

5 It has been shown that the black fluid, furnished by the Meltzer-Lyon test, the so-called B-bile, as collected from the duodenum by siphonage through the duodenal tube, after the instillation of a 25 per cent solution of magnesium sulphate, is mostly a liver product, representing the immediate effect of absorption of the injected substance upon the liver cells. The bile contained in the gall-bladder seems to play no important diagnostic rôle in the cycle of secretions, though frequently some of it will be admixed to the so-called B-bile.

Repeatedly direct visual inspection of the gall-bladder during operation, with the tube in place and the instillation of a 25 per cent magnesium sulphate solution into the duodenum, has failed to show the slightest physical contraction of the viscus, the latter having been under closest observation of the author and his associates for more than twenty minutes.⁸

6 The Meltzer-Lyon test has therefore little, if any, value in diagnostic respects, but it promises to be of great importance in the *treatment* of diseases of the biliary system.

7 Chronic cholecystitis without stones is a much more frequent disease than has been heretofore believed. Clinically, it seems to take the same place in the upper abdomen as chronic appendicitis does in the lower.

Chronic appendicitis, on account of its treacherousness and eventual danger to life, when suddenly flaring up, is generally conceded to be a surgical disease requiring operation. It is no longer a disease of the borderland.

Chronic cholecystitis, as mentioned above, still belongs to the borderland. Though not as treacherous and deadly in its sudden attacks, as the inflammation of the appendix may be, it nevertheless often undermines the patient's health and should, therefore, as a rule require the removal of the gall-bladder.

If only drained temporarily, such a gall-bladder may become the seat of a recurrent inflammation at any time and without any known provocation, it may also harbor stones at a later date. A patient thus afflicted who will not or cannot submit to cholecystectomy, may then pass into a state of chronic invalidism. His gall-bladder represents the same type of infected focus from which absorption takes place intermittently—auto-intoxication—as the tonsils, suppurating teeth and intestinal stasis do.

Cholecystectomy represents the radical cure, and should be advised after the laboratory analysis, outlined before, has established the refined diagnosis.

It appears that cholecystectomy is as well borne by the human system as appendectomy. The mortality of the operation, done in the interval, is almost as negligible as that of appendectomy in the interval stage. Here, too, we may expect that 100 per cent of the patients recover, some extraordinary and unforeseen something, beyond the surgeon's control, would have to happen, if the patient did not recover.

9 Regarding technic, the Perthes incision is favored by the author in the strong male patient in order to restore the abdominal wall to absolute perfection.

He also believes it to be to the best interest of the patient, in the course of cholecystectomy, to advance from the gall-bladder fundus toward the common duct. This will enable the surgeon to meet possible anatomical variations as regards the blood-vessel and cystic duct arrangement (Eisendrath), and will further enable him always to place the ligature of the cystic duct close to the common, thus preventing the later formation of a miniature gall-bladder, as some authors claim to have observed after extirpation.

Temporary drainage of the abdominal cavity after ectomy is considered an absolute necessity. Air-tight suture of the peritoneal sac means taking chances with the patient's life, as the ligature of the cystic duct may give way for unknown reasons a few days after operation, and the leakage of infected bile then cause peritonitis and death.

10 The principal technical advantage, accruing from the preliminary more refined diagnosis of diseases of the bile tract in the presence of gall-bladder—*combined* with appendicular disease, is the indication derived from it with reference to the place of the incision. Knowing *before* operation that the bile is pathologic, we will cut down on the gall-bladder and pull up the cæcum with the appendix, instead of cutting down on the appendix and then palpate the gall-bladder region, as done heretofore. In the latter instance the surgeon can but determine the presence or absence of calculi in the gall-bladder, he cannot feel pericystic adhesions, omental attachments, etc.

11 Inspection and palpation of the gall-bladder during operation must cease to render the only indication for cholecystectomy. The *quality* of the bile, determined systematically, with the help of the duodenal tube *previous* to operation and, if desired, the condition of the bile aspirated from the gall-bladder *during* the operation, must guide the surgeon in his decision of where to incise and what to excise.

Many important questions, naturally, still remain unsolved and require further study, for instance

Is the color of the normal bile always golden-yellow, in other words, does green or brown bile in a gall-bladder, or a mixed color always indicate pathology?

May the wall of a gall-bladder contain microorganisms, and the viscus still be considered non-pathologic? In other words, does the presence of bacteria in the wall of a macroscopically seemingly healthy gall-bladder *always*

represent the first stage of the cycle of the pathological events up to the eventual formation of gall-stones?

Do the bacteria reach the viscus from the duodenum, or by way of the arterial blood stream, or the lymph current?

IV *Final Results*—A final follow-up of results obtained so far in our series of cases of cholecystectomy done for chronic cholecystitis without stones was started, but it has been impossible to complete it and, therefore, cannot be embodied in this paper

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- ⁵Conf Max Einhorn and Willy Meyer Diagnosis and Treatment of Recurrent Cholecystitis without Stones N Y Medical Record, August 7, 1920
- ⁶R. O Brown, Rochester, Minn, "A Study of the Etiology of Cholecystitis and its Production by the Injection of Streptococci" Archives of Internal Medicine, February 15, 1919 Vol 23, No 2, p 185 See also Einhorn and Willy Meyer N Y Med Rec, loc cit
- ⁷In order to obtain positive results of examination as often as possible, it is necessary to spread the bile on a culture medium immediately after aspiration from the bladder, or after incision of the gall-bladder in its aseptic condition directly after extirpation It is further advisable to transversely divide the extirpated bladder which did not contain stones and place half of it into a 5 per cent formalin solution immediately after extirpation for pathologic examination, and have the other half used without delay for tissue culture growth at the laboratory
- ⁸L Aschoff and A Bacmeister, "Die Cholelithiasis" Tena G Fisher, 1909
- ⁹Of course this kind of observation is not convincing, because physiological conditions are changed A gall-bladder may act different with the abdomen closed

SURGICAL MANAGEMENT OF GASTRIC ULCERS*

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THE surgical treatment of gastric ulcer is characterized by a striking uniformity of results. Averages based on statistics from scattered sources show that satisfactory results are being obtained in from 70 to 80 per cent of cases of chronic gastric ulcers in which operation is performed. This average is considerably higher if we include patients whose distress has been alleviated only, so that the number failing to secure any benefit by surgical management does not exceed 5 to 10 per cent. It is this small percentage of absolute and relative failures, however, that the internist emphasizes and that the surgeon regards as a stimulus to increasing the efficiency of surgical methods.

Certain lines of investigation and action could be followed profitably in the endeavor to make the surgical treatment of gastric ulcer even more effective. The part of fœcal infection in the etiology of the disease is of predominant importance, but a systematic, thorough search for an infectious focus has rarely been included in the surgical management. It is true also that the excellent results which follow operation for chronic gastric ulcer have been accomplished with little attention to postoperative dietary or therapeutic management, although it would be logical routinely to carry out an intelligent régime of diet and habits of living. Since these two unquestionably important phases in the treatment of gastric ulcer have been neglected almost entirely in the past, it seems safe to predict that with their full development the number of failures to secure a complete permanent cure will be still further diminished.

The point I wish to discuss in this paper, however, and one which I believe is of great immediate importance, concerns the selection of operation in cases of gastric ulcer. It is very probable that further progress toward maximum good results in this disease will come from the most intelligent selection and application of the methods of treatment which are now known, rather than from additional operative methods. It has become a platitude that the surgeon should have no fixed ideas of the operation he will perform in gastric ulcer until the lesion is revealed. The recent plea by British and European surgeons, notably Moynihan, for more frequent employment of partial gastrectomy for gastric ulcer indicates how unsettled is the question of the most efficient use of the various surgical methods of dealing with the lesion.

The observations in this paper are based on the results of the surgical treatment of 826 cases of gastric ulcer in the Mayo Clinic between January,

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1913 and January, 1920, and they are intended to point out, as specifically as possible, the relative merits of surgical measures of proved value and some of the indications for their selection

There are four main considerations upon which the value of any operation for gastric ulcer should be judged—simplicity, applicability, immediate results, and ultimate results

Simplicity—The simplicity of an operation depends on the ease with which it is performed and the soundness of the principles on which it is based. The popularity of gastroenterostomy is due largely to the fact that it excels in these two respects. Under ordinary circumstances the operation is simple and safe, and its chief purpose, affording rest to the stomach, is fundamentally sound. The value of the relative rest which is brought about by gastroenterostomy has not been sufficiently recognized, and yet it is probably the most important function of the operation. Absolute rest of the stomach can be secured by a jejunostomy, and Moynihan advocates and employs this procedure combined with gastroenterostomy in "Y" for very large fixed ulcers in patients in such condition that all other procedures are contraindicated, he reports excellent results of such management. The relative rest afforded by gastroenterostomy alone, however, seems to be quite sufficient, in all but exceptional cases, to create conditions favorable to the healing of the ulcer.

Another operation which stands out prominently because of its ease of performance is cautery excision, it also is based on sound premises, namely, the effect of heat on infected and malignant tissue. Inasmuch as it is now generally recognized that the best treatment for chronic gastric ulcer must include its radical removal, combined with some procedure to insure symptomatic relief and to prevent recurrence of the ulcer, it is fortunate that we have at hand such simple, safe, and effective measures as cautery excision and gastroenterostomy, the combination of which has been attended by such satisfactory results. Compared with these procedures, partial gastrectomy, particularly when combined with gastrojejunostomy in "Y" is primarily at a serious disadvantage, for the chances of mishap during its performance are too many to warrant adoption of the operation by any but the most skilled and experienced surgeons.

Applicability—No operation compares with gastroenterostomy in its applicability, for often it can be employed when all other procedures are contraindicated, as in an extensively indurated, adherent ulcer high on the lesser curvature, for which resection is not feasible, excision unwarranted, or even destruction by cautery not easily carried out. Not only can gastroenterostomy be performed in such cases, but the results may be expected to be satisfactory in a large proportion of cases. The wide applicability of the operation and the likelihood of its bringing about good results has naturally led to its being performed when conditions definitely contraindicated it and especially when no ulcer existed. The extent of its abuse may be surmised from the fact that it has been found necessary to cut off a number of gastroenterostomies in the Mayo Clinic because the operations had been per-

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formed unwisely. When the operation is indicated there are fewer obstacles to its performance than to any other procedure. Even when the stomach is small and high-lying, and cannot be easily approximated to the jejunum, the anastomosis can be accomplished without undue difficulty. During the last seven years gastroenterostomy has been a part of the surgical management in 82 per cent of the operations for gastric ulcer in the Mayo Clinic, excluding gastric resections.

Immediate Results—One of the most remarkable accomplishments in the surgical management of benign lesions of the stomach has been the steady reduction of operative mortality. The elimination of former dangers directly associated with the operation, namely, hemorrhage, sepsis, and mechanical disturbances, has been largely responsible for the present low average mortality for all types of operation in all gastric ulcers, acute, perforating, and chronic, 2.99 per cent. This percentage has varied but little during the past five years, so that even with more effective preoperative and postoperative treatment and more careful selection of operation such improved methods affect the general mortality rate by only a small margin. The low mortality rate of 1.85 per cent in 213 cases of cautery excision and gastroenterostomy in the Mayo Clinic during a period in which the indications for this operation were not so well known as they now are, is significant. On the other hand, partial gastrectomy for ulcer has been associated with a considerably higher mortality than that following knife or cautery excision and gastroenterostomy, but it should be stated that it has been the practice in the Clinic to resect the stomach only in cases of ulcer with serious complications or those suspected of malignancy. All operative procedures for gastric ulcer are so perfected now that the immediate convalescence of patients is rarely disturbed and serious complications, such as hemorrhage, vomiting, and mechanical difficulties at the anastomosis, have been practically eliminated.

Ultimate Results—It is chiefly in relation to ultimate results that the plea for more radical surgical methods than gastroenterostomy is made, and the question is mainly whether or not the disadvantages of gastric resection, particularly its greater difficulty and its higher immediate mortality, are outweighed by any superior ultimate results which may follow the operation. Ultimate results may be considered under three headings: (1) relief of symptoms, (2) protection against recurrence of the ulcer or occurrence of a new ulcer, and (3) protection against the development of cancer.

Relief of Symptoms—It is fortunate that the results of operation for gastric ulcer, so far as the relief of symptoms of which the patient complained is concerned, can be ascertained readily and accurately without reexamination of the patient. Certain points in connection with such results may be emphasized: (1) Experience has shown that if a patient has had complete relief for a year after operation, it is very unlikely that symptoms will recur, so that statistics and observations based on results after at least eighteen months are relatively accurate. (2) A point to which I have drawn attention in a previous paper² is that some patients, although completely relieved of their

symptoms, may suffer from gastric hemorrhages at a later period, this tendency being greatest in patients who have reported hemorrhages previous to operation. It is imperative, therefore, to deal radically with the bleeding type of ulcer, and since we have made a routine practice of destroying every ulcer, duodenal as well as gastric, associated with a history of bleeding, the incidence of these unexpected hemorrhages has been greatly reduced. (3) Of the patients who did not obtain a completely satisfactory result from the operation very few have not been accorded a greater and more lasting measure of relief than they had secured from any previous medical treatment. It is not difficult, if one seeks to find evidence that will appear unfavorable, to obtain statements from patients that they occasionally have some gastric disturbance following operation, which on fair consideration has no more significance than have similar disorders in persons in normal health. Such disturbances are cited, however, as evidences of surgical failures by those who endeavor to discredit surgery or to discredit a certain type of operation. The final judgment of what the operation has accomplished for the relief of symptoms can safely be based on the opinion of the patient.

Protection Against Recurrence of Ulcer, or Against Occurrence of a New Ulcer—Gastrojejunal ulcer after gastroenterostomy, for example, has been so emphasized because of the numerous papers on the complication that a quite unjustified reaction toward this operation has resulted. It is apparently forgotten that ulcers occasionally recur and new ulcers occasionally form after any type of operation for gastric ulcer. Some known factors which contribute to the formation of ulcers in the line of anastomosis are the irritation of permanent suture material, unnecessary trauma caused by clamps or forceps, and a neglected hæmatoma. These are controllable factors, but the greatest advance towards preventing the occurrence of these new ulcers will be, I believe, the routine eradication of all septic foci and adoption of a proper postoperative dietary and therapeutic régime. The complete protection against recurrence of ulcers in any part of the stomach probably depends largely on the thoroughness of such measures.

Protection Against Cancerous Degeneration—The danger of cancer developing on a gastric ulcer for which gastroenterostomy alone has been performed has been variously estimated. Kocher placed the figure at 2 per cent, von Eiselsberg at 4 per cent, while Coffey has found recently that in his own large experience cancer actually developed more frequently in cases in which excision was performed than in cases in which gastroenterostomy alone was performed, the latter incidence was only one in 163 cases. Our records show that in 214 cases of simple gastroenterostomy there were five patients in whom death from cancer occurred more than two years after operation. It must be remembered, however, that the percentage of late deaths following gastroenterostomy is higher than the percentage following

any other operation. While it is not known how many in the former group die of gastric cancer, it is fair to assume, because of the absence of proof of the true character of the lesion at the time of operation, that a considerably larger number die of cancer than is known. One of the most interesting questions in this connection is whether gastroenterostomy alone, for an ulcer which has already taken on early malignant changes, does not, besides healing the ulcer, delay growth of the cancer cells already implanted. There is some evidence to show that this occasionally takes place, but very little evidence to support the view that cancer frequently develops on a really benign ulcer which has been gastroenterostomized. From all information we have been able to obtain on the subject, we have found that cancer has been known to develop, during a seven-year period, in thirty-three of the 799 cases of gastric ulcer in which operation has been performed in the Mayo Clinic. These known cases of cancer developed after every type of operation, and, what is of great importance, with apparently no less frequency following partial gastrectomy than following knife or cautery excision and gastroenterostomy. This whole question of subsequent results in relation to the different operations needs continued study. There is one certain fact, namely, that no operation for gastric ulcer will absolutely assure a patient that he will not die of gastric cancer. Whether the incidence of cancer after any operation which includes radical removal of the ulcer is any higher than the normal incidence of the disease remains to be settled and, if proved, explained.

This review of the relative merits of the various methods of dealing with certain types of ulcers and the attempt to establish indications for the operations are based on the experience with these methods in the Mayo Clinic, and a study of their immediate and late results.

Ulcers of the Lesser Curvature —Ulcers of the lesser curvature, including those closely associated with the lesser curvature on the anterior or posterior wall, comprise almost 90 per cent of all gastric ulcers. Small ulcers of the lesser curvature, that is, ulcers with craters less than 1 cm in diameter, when situated in the pars pylorica or pars media, and without extensive induration or perigastric adhesions, have been best managed in our experience, from the standpoint of immediate and end results, by knife or cautery excision combined with gastroenterostomy. From the standpoint of operative management cautery excision has certain distinct advantages over knife excision, and the late results of cautery excision combined with gastroenterostomy, when the procedure has been wisely chosen, are at least as good as those obtained by knife excision and gastroenterostomy.¹ If either method of excision has been performed radically, the danger of cancer developing is negligible. The value of heat as a destructive agent to the cancer cell, which may already have been developed in the tissues surrounding the actual ulcer, has been well established. For small ulcers on the lesser curvature in positions less easily accessible, excision, preferably by cautery, followed by gastroenterostomy, is very satisfactory and as a matter of fact is the only radical treatment that can be carried out safely. Gastric resection is certainly not warranted

in these small, high-lying ulcers because of its technical difficulties, because the amount of healthy stomach removed is out of all proportion to the size of the ulcer, and because of the efficiency of cautery excision and gastroenterostomy. It may be doubted whether any method of surgical management of these smaller ulcers, in whatever position on the lesser curvature, will prove to be more successful than excision by cautery and gastroenterostomy, which give satisfactory results in more than 80 per cent of the cases, and an operative mortality of only 18 per cent.

Ulcers of the lesser curvature with a crater larger than 2 cm in diameter, with extensive induration, adhesions to neighboring structures and organs, and indications of possible malignancy, must be dealt with quite differently from the small, uncomplicated ulcers, to insure the best possible results. If a large ulcer is near the pyloric end of the stomach, pyloric resection is the operation of choice, unless the lesion is so fixed to surrounding tissues and is in such an inflammatory state that its mobilization is unwise. Under the latter circumstances gastroenterostomy is clearly indicated and it will give excellent immediate results with a fair prospect of permanency. The indications for subtotal gastrectomy become less clear the farther an ulcer of this type is from the pylorus, although as long as such an ulcer is reasonably accessible and can be mobilized safely, gastric resection is the best procedure. Beyond this point of reasonable accessibility, resection is inadvisable because of the reasons already mentioned, and because of the distinctly additional risk. When the lesion is in the body of the stomach and is associated with hour-glass deformity, resection in continuity is a useful technical procedure which will give good immediate results, but sometimes the ultimate results in our experience have been marred by disturbances in motility due to contracture in the site of anastomosis. Deaver and Pfeiffer have recently reported better results from this operation by adding a gastroenterostomy distal to the circular anastomosis.

The selection of the best operation for the small, uncomplicated ulcers and the large, complicated ulcers of the lesser curvature is not difficult. When an ulcer between these two types is met with on the lesser curvature, however, the best operation is not so easily chosen. Again the important question is that of malignancy. There are no hard and fast rules by which early malignant changes in an ulcer can be recognized, so that differentiation is not easy or certain, but it is a fact that the subsequent course of doubtful cases shows that errors in interpretation are rarely made and when they are it is much more likely that an ulcer has been erroneously labeled "cancer" than a cancer mistakenly called "ulcer." The danger of a primary gastric cancer or a cancerous ulcer being wrongly diagnosed or unrecognized by the combined findings of a well-qualified internist, a roentgenologist, and a surgeon, I believe to be most unlikely, and it is surprising how few of the gastric lesions diagnosed clinically, roentgenographically, and at operation as benign ulcers, prove to be malignant on pathologic examination following radical removal of the ulcer. The incidence of such cases in the Mayo Clinic

has not exceeded one or two per cent. The method of removing a substantial slice from the ulcer and subjecting it to immediate microscopic examination, while not absolute in determining whether malignancy is present, has proved to be most valuable and is quite justified, providing the ulcer is immediately destroyed by cautery, whether or not malignancy is reported on pathologic examination. The procedure is carried out routinely in the Clinic in cases which really are not suspicious of malignancy, adding, of course, a gastroenterostomy. If, however, any part of the examination raises the possibility of malignancy, if the ulcer is favorably situated for resection, and conditions warrant it, partial gastrectomy holds first place, although the higher operative risk demands that the operation be well justified before it is attempted. The farther from the pylorus ulcers in this borderline group are encountered, the less definite become the indications for subtotal gastrectomy, particularly for the surgeon whose experience has not been large in this field. The best surgical management of these cases is, I believe, gastric resection when proof of malignancy is established, gastric resection, if it can be performed without an abnormally high mortality, when there is strong suspicion of malignant degeneration, radical cautery excision and gastroenterostomy, if the resection cannot be performed without an abnormally high risk, and, in all other cases, cautery excision and gastroenterostomy, except in cases of ulcer so near the cardia that access is too difficult, when gastroenterostomy alone will often give surprisingly good results. In cases of very extensive ulcer the usefulness of jejunostomy should be remembered.

Ulcers of the Posterior Wall—After the lesser curvature the most common site of ulcer is the posterior wall about 10 per cent of all gastric ulcers occur there, and 75 per cent of these are in the pars media. The surgical management of these is technically more difficult and is not as yet attended by as satisfactory results as follow operations for ulcers of the lesser curvature. Such ulcers usually have extensive craters and are attached to the pancreas, and the patients are often in poor condition. It is a requisite of any operative procedure undertaken for such ulcers that the stomach and pancreas shall be separated if good results are to be obtained. This separation may be accomplished by various approaches, such as transgastric, through the gastrohepatic omentum, or through the transverse mesocolon. W. J. Mayo has recently stated his preference for the gastrohepatic omentum route as the avenue of approach because it is simplest, most applicable, and most effective in exposing the ulcer and its attachments. The ulcer having been separated and specimens removed for microscopic examination, the edges of the opening in the stomach should be thoroughly removed by cautery, the raw surfaces of the pancreas seared, the opening in the stomach closed, and gastroenterostomy performed. If cicatrization has developed to a point in which there is hour-glass deformity in the body of the stomach and the ulcer itself can not be dealt with satisfactorily, sleeve resection combined with gastroenterostomy deals very adequately with the pathologic condition and with the deformity, although symptomatic relief is not certain.

When posterior ulcers are situated near the pylorus (only 8 per cent of them are in this situation), pyloric resection is the operation of choice

Ulcers of the Anterior Wall—Ulcers of the anterior wall constitute only 1 per cent of gastric ulcers. If the ulcer is small it can be excised primarily with the knife or cautery and direct closure made, or, if the ulcer is near the pylorus, a plastic operation may be advisable. The pyloroplasty of Finney has a definite application in small, non-adherent ulcers in close proximity to the pylorus, although its value seems to be chiefly in dealing with ulcers on the duodenal side of the pylorus rather than on the gastric side. The operation permits of radical removal of the ulcer and direct inspection of the posterior wall of the stomach and duodenum.

For large ulcers of the anterior wall near the pylorus, especially when they have perforated and become adherent to organs and structures, pylorectomy is justified if mobilization does not involve too wide a dissection into inflammatory tissue, but it should be remembered that these "pyloric" ulcers are almost always duodenal and hence not subject to malignant changes. The same indications for pylorectomy exist when malignancy is suspected or proved, as I have already pointed out. If pylorectomy is not advisable, gastroenterostomy alone, without separation of the ulcer from its attachments or any radical treatment of it, is the operation of choice. Should a diagnosis of malignancy or probable malignancy be made at operation and it seems unwise, because of the patient's condition or the condition of the operative field, to resect the growth, gastroenterostomy may be performed as a first-stage operation in anticipation of performing resection as the second stage when conditions are favorable. Nothing illustrates so well what gastroenterostomy will accomplish as its visible effect on these large, adherent lesions, and experienced surgeons all testify to the fact that when the abdomen is opened for the second stage, these ulcers, supposedly malignant, have occasionally entirely disappeared.

To the few remaining types of ulcers of the anterior wall and of the greater curvature the general principles that have been suggested may be applied.

The indications outlined for the choice of operation in gastric ulcers of various types and situations are necessarily somewhat general, but they are based on a careful study of the results of operations for 826 gastric ulcers in the Mayo Clinic during a seven-year period. It seems quite safe to conclude from these results that there is every justification for adhering to the practice of excising, preferably by cautery, the benign chronic gastric ulcer, and combining a gastroenterostomy with the excision. The results in this series of cases do not indicate that more radical treatment, gastric resection, is a preferable method in any considerable percentage of non-malignant ulcers.

It is encouraging to note in summarizing that we were able to trace 85 per cent of the patients in this series. More than 70 per cent report complete relief, 10 per cent report marked improvement, and 4 per cent only report no relief.

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THE ALTERED ANATOMY AND PHYSIOLOGY OF THE CÆCUM AND ASCENDING COLON, THE RESULT OF ADHESIONS*

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THE importance of adhesions involving the abdominal viscera in the causation of symptoms of various degrees of severity has long been recognized. In the past, however, these symptoms have often been discussed in a general way, and the results of abdominal adhesions have been often considered as consisting principally of indefinitely localized abdominal pain and more or less disturbance of the functions of the gastrointestinal tract. An exception to this viewpoint has, of course, always existed in those cases in which there has been acute obstruction of some portion of the intestinal canal.

Gradually, however, the fact has become established that the term "adhesions" is not sufficiently clear, that we must try to separate as clinical entities those groups of cases in which the adhesions affect principally the anatomy and physiology of a definite portion of the intestinal tract.

Moreover, I consider it to be established that adhesions involving the cæcum and ascending colon to such an extent as to cause symptoms can often, indeed, as a rule, be correctly diagnosed, that they give a distinct symptomatology, and that a definite line of treatment, surgical or otherwise, is indicated when such a diagnosis is made.

Any consideration of the treatment or symptoms of such derangements must rest upon a consideration of the variations from the normal anatomy and physiology of the parts affected, and upon certain factors concerning the nature and origin of the adhesions we have to deal with.

Normally the ascending colon is the largest portion of the intestine, the cæcum being its largest portion. In the majority of cases the cæcum has a freer range of motion than the other portions of the large gut, the ascending colon being, as a rule, fixed in the right iliac fossa and right kidney space. In but 25 per cent of cases is there a distinct mesocolon for this portion of the intestine.

Physiologically, two points are to be noted as regards the ascending colon. (1) Its contents are semifluid or fluid and it is here that a large part of the water from the fecal stream is absorbed. (2) It is characterized by antiperistalsis, the wave being stopped by the closed ileocæcal valve. This reversed peristalsis has for its object the thorough mixing of the food contents before the withdrawal of the fluids. When the mixture is right, true peristalsis replaces the antiperistalsis, the food is pushed along to the transverse colon, and the ileocæcal valve opens for the admission of a fresh supply.

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of material from the small bowel. It must be realized that in this lift of material alone, the individual being in the vertical position, considerable work is done by the musculature of the cæcum and ascending colon, and even a slight additional burden caused by pathological conditions may render normal function impossible.

The ascending colon, by its location, structure and function, is not much affected by acute inflammatory conditions arising within or from it. The mechanical effects of occlusion by neoplasm are well known and need not be discussed here. The most frequent cause of malfunctioning of this portion of the gut is adhesions. Excepting those cases in which we find adhesions within the abdomen following upon a definite infectious peritonitis—in which event the adhesions naturally correspond in location to the site of this process—the right iliac fossa is by far the most frequent site of those bands, folds and adhesions with which we are now dealing.

In a previous communication¹ I have laid stress upon the fact that these bands, folds and adhesions are, as a rule, not the result of faulty development or failure in the descent or rotation of the gut, but are inflammatory, caused by a peritonitis, acute or chronic, recognized or unrecognized, in adult life, infancy or the prenatal period. I believe that a recognition of this fact will do much to do away with the hesitation with which many surgeons approach the cure of conditions resulting from them, and with faulty surgical procedures which attempt an approach at correction from the wrong angle. The surgeon who deals with such adhesions must attempt to relieve symptoms due to them and to prevent their recurrence, not to reconstruct an intestinal canal according to his ideas of its physiology. Since these adhesions are, as a rule, inflammatory, they produce alterations of greater or less degree in a gut previously normal or nearly so. The inflammatory process causing them may have occurred at any period, and may not, indeed frequently does not, have symptoms severe enough to justify a clinical diagnosis of peritonitis. Its results are, however, of the same nature, if not the same degree, as those caused by a definite purulent peritonitis, *ie*, abdominal adhesions are distinguished from those possibly non-infectious agglutinations, transient in nature, referred to by certain authors². In other words, the results involve destruction of the endothelial layer of the serosa, with subsequent formation of permanent pathological structures binding together certain of the abdominal viscera.

To approach correctly the treatment of such adhesions involving the cæcum (with the ileocaecal junction and the ascending colon), we must consider their grouping (1) As to their extent and their location, (2) as to their anatomical effect by traction upon the abdominal viscera, (3) as to the systemic and local symptoms produced.

1 Since the degree of frequency and extent of the peritonitic process causing these adhesions varies so greatly, it follows that in a given case the adhesions may be of the slightest extent or so dense and extensive as to almost obscure the normal anatomy of the parts. Strange as it may appear,

a few small adhesions may by their location cause a far more marked symptomatology than far more evident structures not so disadvantageously placed. Adhesions seriously interfering with the ileocæcal junction, causing fixation when the rest of the intestines in this region are ptosed, give probably greater distress than far greater structures obstructing only the cæcal lumen.

2 Adhesions about the cæcum and ascending colon do not necessarily give symptoms confined to these structures. They may cause interference with the gastrointestinal tract in any of its portions. We must consider among other conditions (a) Malposition of the stomach associated with ptosis and fixation of the transverse colon, caused by adhesions, (b) traction upon the duodenojejunal junction due to adhesions in the ileocæcal area,³ (c) possible gastric lesions of an organic character superinduced by malposition caused by adhesions lower down,⁴ (d) traction upon the splenic and hepatic flexures by the misplaced transverse colon and fixed ileocæcal region.

3 Bearing in mind such conditions as these, we may approach a rational attempt at classification of the symptoms due to interference with the cæcum and ascending colon.

The local symptoms are. Pain about the ileocæcal junction and hepatic flexure, more or less constant with occasional marked exacerbations, tenderness, not localized to McBurney's point, but more diffuse, a feeling of actual stoppage of intestinal contents, *especially gas*, at the hepatic flexure. Fluoroscopic examination often displays a fixed point at the ileocæcal junction, hepatic flexure, or both, with delayed passage of intestinal contents. There is frequently a constriction, posterior displacement and fixation of the terminal portion of the ascending colon and hepatic flexure. Often there is an associated dilatation of the cæcum and first portion of the ascending colon.

As referred local symptoms, must be mentioned especially the gastric ones, *i.e.*, so-called dyspepsia without evidence of gastric disease, *but with tenderness in the right iliac fossa* often manifested, vomiting without gastric or upper abdominal cause and associated with fluoroscopic evidence of disturbed physiology of the cæcum and colon.

The functional symptoms are due to delay in the handling of the intestinal contents by the large gut—constipation, intestinal torpor and distress due to the excessive formation of gas and its slow and painful progress along the gut tube. The systematic symptoms are directly due to this coprostasis, with the excessive absorption of putrefactive materials. They may range from mere weakness, malaise and listlessness, cold feet and hands, and chronic headache, to the most extreme depression with secondary joint and other lesions due to what is practically fecal infection. Fortunately these severe cases are rare, for they are most intractable under any form of treatment.

It seems to me that careful study of a given case, and a consideration of the local and general symptoms, with careful X-ray studies, will in most instances enable us to make a correct diagnosis of cæcal (ileocæcal) and colonic adhesions.

Our ideas upon treatment should take just as definite a form

It can be broadly stated that the cases, insofar as treatment is concerned, fall easily into three groups.

1 Those cases in which the symptoms, due to a minor grade of adhesions, accompany a general ptosis of the viscera in individuals of the so-called "neurasthenic type." In these instances the difficulty caused by the adhesions is not the patient's major ailment. Attempts at surgical cure of such patients are rarely successful and have been in the past a cause of much unfavorable comment upon the surgery of intestinal conditions in general.

2 Those cases in which the adhesions themselves are the main or only cause of the symptomatology, giving rise to those local and general symptoms previously described. Either the local or general symptoms may predominate. If the local evidences are not marked, and the systemic effects are grave, careful study is necessary not only to demonstrate the cause of the general symptoms but also to eliminate those cases in which the intestinal lesion but accompanies other underlying factors.

3 Those cases with most severe general symptoms, in which the visceral conditions are such as to call for extensive surgical procedures—such as resection of the colon. Fortunately such cases are extremely rare. The primary mortality is high, and while there have been occasional brilliant results they have been so few as to discourage frequent attempts at such surgery.

My conclusions as to symptoms and treatment of the lesions under consideration are based upon the observation of a considerable number of cases.

I have been able to collect from various hospital services the records of thirty-six cases I have operated upon since I have made routine examinations for abdominal adhesions involving the colon and ileocæcal region whenever an abdominal operation is performed. The records are by no means uniform and it has been difficult to follow some of the cases. I have classified the thirty-six cases as follows:

1 Those in which the main pathological condition was an ileocæcal interference due to a Jackson's membrane or Lane's kink, with or without chronic appendicitis. There were nine such cases.

2 Cases more correctly to be classed only as "adhesions" involving the ascending colon and ileocæcal region. These were fourteen in number.

3 Cases in which a major surgical condition associated with those under consideration as also operated upon. These were three: one case of cholelithiasis, one case of salpingo-oophoritis, one high inguinal hernia.

4 Cases of abdominal adhesions (three classed as Jackson's membrane) in which the records were insufficient to permit of proper analysis.

Of the nine cases of Jackson's membrane in which adequate records were found, eight had an appendectomy performed at the same time, one had had an appendectomy four years previously with no benefit. In four of the nine cases a diagnosis of adhesions involving the ascending colon or hepatic flexure was made before operation, in two of these Jackson's membrane was definitely noted as a cause.

Symptomatically the cases resembled each other in all having a history of abdominal pain. Usually this pain suggested perhaps appendicitis, subacute in type. An occasional patient (F K M) would describe more in detail symptoms pointing to partial bowel obstruction and stasis rather than those leading to a diagnosis of inflammatory disease. One case had joint and toxic symptoms of long standing—these entirely relieved by the operation.

In eight of the nine cases a record of the ultimate result is at hand: six were cured (one still complaining of constipation), one (Mrs Geo I) was benefited ("partially cured," September 30, 1920), one was benefited, but still seems to be in very poor shape. The operative recoveries in all of these nine cases were uneventful.

In all of the cases the appendix when still present was removed, the adhesions were freed, the surfaces covered with peritoneum where possible and swabbed with paraffin (or olive) oil.

There were fourteen cases of adhesions. Of these nine were cured with possible minor symptoms remaining, two were improved, one was unimproved, two died.

Among the cases much benefited (*i e*, cured) the following brief note of the pathology, symptoms and treatment may be given:

Pathology	Symptoms	Treatment
1 Sigmoid tied to lateral abdominal wall, chronic appendicitis	Upper abdominal	Appendectomy, release of adhesions
2 Adhesions of omentum and almost complete obstruction of ascending colon, chronic appendicitis		Appendectomy, release of adhesions
3 Subacute appendicitis, subacute peritonitis, young adhesions RIF	Lower abdominal, plus nausea and vomiting	Appendectomy, release of adhesions
4 Abdominal adhesions anchoring ascending colon and hepatic flexure, chronic appendicitis	Constipation	Appendectomy, release of adhesions
5 Adhesions about head of cæcum, chronic appendicitis	Pain, right lower abdominal segment	Appendectomy, release of adhesions
6 Adhesions (location), chronic appendicitis	Apparent attacks of subacute appendicitis	Appendectomy, release of adhesions
7 Retrocæcal appendix, subacute, omentum constricting ascending colon, five years old	Attacks of appendicitis	Appendectomy, release of adhesions
8 Previously operated, adhesion involving hepatic flexure and transverse mesocolon, anchoring stomach to right of midline	Generalized abdominal pain and pain on walking, constipation	Release of adhesions
9 Previous operation, adhesions, ascending colon, duodenum and pylorus	Very general abdominal symptoms	Release of adhesions, rejection /R broad ligament

An analysis of these successful cases demonstrates that attention to the local pathology (appendicitis), etc., with release of adhesions only and meas-

ures to prevent their recurrence, often results in a cure. It has not been found necessary to perform resections, plications or intestinal anastomoses. There can be no doubt that more extensive operations would have been associated with greater mortality—the results could hardly have been more satisfactory.

In the one totally unsuccessful case a dense band of adhesions involved the ascending colon, causing angulation and fixation. It is also noted that the stomach was ptosed to below the umbilicus. The patient developed a slight hernia through the upper angle of the incision. Nine months after the first operation she was operated upon by another surgeon—with what result I do not know.

Two cases of this series died. One with extensive colonic adhesions died of acidosis five days after operation. The second case died within forty-eight hours after operation. This patient was not in good condition before operation and had very extensive adhesions. She died with symptoms suggestive of peritonitis, confirmed at post-mortem examination.

In connection with those instances in which the adhesions are extensive and the gut has been kept from functioning normally for a long period of time, it may be noted that for a number of days immediately after operation the patient may suffer from symptoms suggestive of toxic absorption. The relaxed and poorly muscled intestine cannot propel the faecal material quickly enough and temporary stasis with excessive absorption of harmful materials takes place. When this becomes extreme an acidosis, perhaps fatal, supervenes. Measures to combat this possible condition should be undertaken immediately after operation in every instance. Sir A. Lane attributes some of these symptoms to interference with lymphatic channels formed within the adhesions and advises drainage after extensive operations even when the intestine is not entered.

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CARCINOMA OF THE LOWER PART OF THE SIGMOID IN A BOY FOURTEEN YEARS OF AGE*

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CARCINOMA of the large bowel in young persons is a rare condition Louart¹ in 1900 collected from the literature only nine cases occurring in youths up to twenty years of age Clogg² in 1908 collected seventy-two cases of cancer of the colon The youngest of these patients was fifteen years of age

Merkel,³ in his article of Tumors of Childhood in 1912, states that "The literature on the subject of malignant tumors in childhood must be accepted with some degree of caution since many of the cases lack histological confirmation"

Weinlechner in 5279 cases of carcinoma observed eighteen (0.34 per cent) among children up to fourteen years of age Feldner in 914 cases of carcinoma met with only three up to the sixteenth year of life

Philip, in his inaugural dissertation on Carcinoma in Childhood (Munich, 1908), reviews the older and more recent literature Among 390 cases collected by him only eighty-seven seemed sufficiently genuine to warrant consideration Classified according to location and organs involved, he found the following regions to be entirely immune to carcinoma lungs, tongue, œsophagus, hypophysis (Erdheim, however, subsequently published two cases of malignant growth of the hypophysis), urinary bladder, penis, seminal vesicles, tubes, mamma Merkel calls attention to the fact that the list comprises precisely those organs in which carcinoma in the adult is referable to chronic irritation

The digestive tract was affected in 46 per cent of the cases, and the sigmoid in only 5.4 per cent In 111 cases, the large bowel was affected in 28, of these the sigmoid was involved in seven cases

PARKINSON⁴ reports case of a boy, aged nine years, who died six months after onset of symptoms No operation The autopsy showed that the abdominal lump (palpable *intra vitam*) proved to be the sigmoid lying in the right iliac fossa and adherent to the adjacent small intestine The wall of the sigmoid was thickened with a hard, whitish growth, the inner surface was ulcerated, no trace of mucous membrane remaining The wall was one-third inch thick, the external surface was smooth There was no constriction of the gut Other organs normal

Microscopic sections showed "large rounded and tailed cells packed in the midst of fibrous tissue alveoli In some parts this is replaced by a granular, structureless, apparently colloid substance, taking the stain badly It is, I think, a carcinoma"

* Read before the American Surgical Association June 14, 1921

CARCINOMA OF THE LOWER PART OF THE SIGMOID

The author also refers to a case observed in a girl twelve years of age

BARBER⁵ reported a case of a boy of nineteen years. He was admitted to the hospital with symptoms of acute intestinal obstruction. Cancer history in the family, the mother having died of intestinal carcinoma.

The patient gave a history of intestinal cramps for one year, aggravated during the past two weeks, causing inability to work. He had always been constipated, but had no pain when the bowels acted. Two days before entering the hospital, the patient vomited persistently. There was no evidence of blood in the vomitus, or colonic washings. The abdomen was very tender, rigid and distended, especially on the left side and at the umbilicus.

A median incision disclosed a large indurated mass involving the upper extremity of the sigmoid. Above this mass the intestine was very much distended. There was very marked enlargement of the lymphatic glands in the mesosigmoid and upwards in the pre-aortic lymphatic glands. Complete excision was impossible. The tumor and regional lymph-glands were excised. An end-to-end union of the bowel was made. The patient recovered and left the hospital improved. A later report stated that he had lost weight and strength, which indicated that he was undoubtedly suffering from metastases. The pathological report was adeno-carcinoma.

PERSONAL CASE—The patient, Gordon Smith, aged fourteen years, entered the Hamilton General Hospital on February 16, 1920, complaining of pains in the abdomen, frequent stools of blood and mucus, with rectal tenesmus. He gave the following history. About four months ago he began to suffer from irregular abdominal pains, sickness and nausea when taking his meals and frequent desire to go to stool. He lost flesh and the spasmodic abdominal pains became more frequent, and when at stool instead of passing fecal matter, only a little blood and mucus came away. This was always accompanied by spasm and pain in the rectum. At first the pains were more frequent during the day, especially so when eating his meals, but during the past few weeks he was compelled to go to the toilet two or three times during the night and the rectal tenesmus became more pronounced.

His family history is good. Both parents are living and healthy and there is no history of tumors or cancer in his family. With the exception of whooping-cough he has had no previous illness.

Present condition. He is a small, emaciated looking little chap weighing only sixty-two pounds. His face has a drawn expression, with wrinkles between his eyebrows. His heart and lungs are normal. The urine is negative to casts, albumen and sugar. The abdomen is distended and marked peristalsis is seen and felt in the transverse and descending colon. When his peristalsis comes on, the descending colon and sigmoid is shoved over to and even beyond the median line. After the spasm has passed off, a lump can be felt at the lower end of the sigmoid. On rectal examination, an irregular mass can be distinctly felt. The abdominal wall is so thin that the distended colon can be

easily mapped out The lad stated that sometimes when sitting on the closet, something seemed to come out of his anus

It was somewhat difficult to decide the exact nature of the growth, as it hardly seemed likely that a boy so young would be affected with a cancer of the large bowel, yet, had this condition been seen in an adult fifty years of age, I would have had little hesitation in making a diagnosis of cancer The patient had been in the hospital nearly two days before I saw him and as his condition was not very good, I operated immediately The abdomen was opened and the growth was found at the junction of the rectum and lower end of the sigmoid The bowel above the growth was very much distended with fecal matter The rectum was likewise very much dilated and there was a partial intussusception of the tumor into the rectum No enlarged lymph-glands were found and no nodules could be felt in the liver Owing to the great mobility of the sigmoid and descending colon, the mass was easily brought well out of the abdominal wound and excised The proximal bowel was so packed with a thick clay-like fecal mass, that it seemed wise to empty it before putting in a Paul's tube The peritoneum was closed around the two projecting ends of the bowel and the skin and muscles approximated by a few sutures of silkworm gut As the operation was not a lengthy one, very little shock followed It was necessary, however, to remove the Paul's tube on the second day, as it became blocked with fecal matter The wound became infected and the stitches were removed The lad, however, was entirely relieved of pain, was able to take plenty of food, but did not seem to thrive He became thinner and thinner He was then taken to the roof of the hospital and kept in the open air He improved immediately and gained flesh rapidly The wound healed up around the divided ends of the bowel and on April 15th, nearly two months after his first operation, a junction of the two free ends of the bowel was made This was, unfortunately, not quite a success, as a small fecal fistula developed, which, however, gradually closed, and he left the hospital on June 6th

He has reported at my office several times during the last year and his weight has increased more than 50 per cent His present health is excellent

Pathological report made by Dr W J Deadman, pathologist of the General Hospital, Hamilton, is as follows

Gross Appearance—The gross specimen consists of about seven inches of large bowel, in the centre of which is a cauliflower-like growth completely encircling the bowel and causing partial obstruction of its lumen This tumor mass is raised about three-fourths of an inch above the general level of the mucosa, and is papillomatous in appearance The bowel wall beneath is apparently infiltrated by the growth, although the peritoneal surface has not been broken through In some parts of the tumor there seems to be production of mucoid material

Microscopic Examination—Histological examination of the tissue shows varied forms of atypical growth of gland epithelium In



FIG 1 —Carcinoma of Sigmoid, Case—Gordon Smith One inch of the bowel above and below the tumor has been trimmed off in mounting the specimen which on removal was seven inches in length. The width of the base of the tumor is two inches



FIG 2—Carcinoma of Sigmoid Case—Gordon Smith H P field of section of tumor Magnification $\times 10$



FIG 3—Carcinoma of Sigmoid Case—Gordon Smith Magnification $\times 400$ Showing Mitotic Figures

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some places there is an irregular formation of gland acini, many of which are lined by high columnar epithelium, while others show a marked heaping up of the epithelial cells. Some of these acini are distended and cystic, while in other places there is invasion of the underlying tissue by solid strands of epithelial cells. The interstitial tissue shows some areas of infiltration by polymorphonuclear leucocytes. In one area several epithelial cells are seen in mitosis. Diagnosis—adeno-carcinoma.

In patients where there is an old chronic obstruction the fecal matter above the obstruction becomes so thick and difficult to get rid of, that it will not go through a Paul's tube. In a number of such cases I have made use of a suggestion of the late Doctor McGraw, of Detroit. He mobilized the growth, brought the mass outside of the abdominal wound and placed his elastic ligature through the two healthy portions of the bowel above and below the growth. Instead of using his ligature, and where it is possible to milk back the contents of the proximal bowel, I make a similar anastomosis with sutures, remove the mass, close the divided end of the lower segment and leave the proximal end open for drainage. This acts as a safety valve and gradually contracts and is easily closed later.

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THE SURGICAL TREATMENT OF MEGACOLON*

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It is nearly a century since Parry described a case of megacolon—observed at autopsy, in an adult who had suffered from digestive disturbance for years. This colon was enormously distended, and contained an immense quantity of fæces. We do not know what observations had preceded his, but between 1825, the date of his publication and 1886, the date of Hirschsprung's first article, there were at least twenty-six publications about these tremendously enlarged colons. Hirschsprung's articles stimulated attention to the subject and they came at a time when abdominal surgery and abdominal pathology were receiving increased attention, hence when Finney wrote his classical article in 1908 he found a bibliography of 206 articles. Since that time the literature has increased even more rapidly, and is now so large that it is hardly possible to grasp it in full detail.

Method of Occurrence—Congenital idiopathic dilatation of the colon (Hirschsprung's disease) has generally been considered, in large degree, a disease of childhood. There are a great many descriptions of the disease occurring in children. They surely make the most vivid pictures. Hirschsprung advocated the name of "true" megacolon for them and the name of "pseudo" megacolon for those cases occurring in adults. With the later development of the subject this distinction has not always held. Many observers believe that if some patients with this disease can worry along to adolescence, others can reach adult life and that there is no proper age limit. The subject has been complicated by the including of reports of localized megacolon. Even in the undoubted congenital cases the sigmoid is more apt to show dilatation than the rest of the colon; the intestine angulates at the fixed points and distends elsewhere, although after its removal it may be as large at a point of former angulation as at a point of former dilatation; hence it is not strange that there should be many reports of localized megacolon. However, the custom of reporting such cases has led to the description of an increased number of adult cases, and an increased proportion of cases in whom the mechanical factor of obstruction predominates. Hence considerable confusion has resulted, and it is now impossible to differentiate in the literature those patients in whom the enlargement of the colon is due to a congenital defect from those in whom it comes from mechanical or spasmodic obstruction. We know, however, that enormously dilated and hypertrophied colons are observed in children, and that similar conditions are sometimes

* Read before the American Surgical Association, June 14, 1921

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seen in adults, also that the adult cases in the main show greater evidence of mechanical or nervous obstruction as causative factors

Pathology—The degree of dilatation which these colons reach is almost beyond belief. Finney states that the circumference of the abdomen may be greater than the height of the patient and quotes Peacock as describing a colon which contained sixteen litres. Graves describes a colon 110 cm long and 31 cm in circumference in its descending portion. Bensandi and Sorrel describe one 26 cm in circumference. Johnson describes a colon which contained three or four quarts of fæces. From the second case recorded in this paper at least one gallon of semifluid fæces were withdrawn on the operating table, and about another gallon drained away in the next two days. The removed portion of the colon in Case I easily held four litres of fluid after its removal. The walls of the colon are usually hypertrophied as well as dilated, especially in their circular muscular coats. The mesocolon may be lengthened and hypertrophied in all its elements. Obstructive valves have been described. Volvuli have been found. A few anal fissures have been described giving suggestion of spasmodic obstruction above.

Etiology—There are three main theories for the etiology

- 1 That it is due to congenital defect in the development of the colon
- 2 That it is due to some form of mechanical obstruction, and that the colon hypertrophies and dilates in its efforts to overcome this obstruction, just as the heart hypertrophies and dilates when increased demand is made upon it
- 3 That it is due to spasm of the circular fibres in the lower part of the intestine, and that dilatation of the colon follows this spasm just as dilatation of the œsophagus follows cardiospasm, or dilatation of the stomach follows pylorospasm

It is altogether probable that two or more of these elements are active in many of the cases.

Symptoms—The main symptoms are abdominal distention, constipation lasting sometimes for very long periods, intermittent diarrhœa, loss of appetite, emaciation, apathy.

The study of the treatment of the disease is the main purpose of this paper. Very careful consideration of its occurrence, pathology, etiology, and symptoms is given in other papers, particularly that of Finney to which readers are referred for such information.

RECORD OF CASES

CASE I—E. F., aged ten and a half. The Roosevelt Hospital. History No 16873. A. First seen by writer March 31, 1920. She had reasonably good health during the first seven years of her life, then loss of strength and listlessness. At eight and a half years irregular attacks of abdominal pain began, in epigastrium and on both sides. They were accompanied by constipation. Her disability progressed, by December, 1919, she had become a real invalid, taken about from one doctor to another in search of relief from her distress, weakness, pain, alternating constipation and diarrhœa and frequent micturition.

When admitted to the hospital she was found to be a thin, emaciated child of

sixty-one pounds weight, and having a very large abdomen. The left half of the abdomen contained a large, rather soft, slightly movable mass. Enemas brought away an enormous quantity of faeces and the mass disappeared. No obstruction could be found in the rectum. X-ray examination after a barium enema showed a dilated sigmoid (See Plate 1). It was not found practicable to give enough barium mixture, either by mouth or rectum, to secure a picture of the entire colon in a dilated condition.

Operation—After ten days of further treatment by medicine, diet and enemas an operation was done. A seven-inch incision was made through the inner part of the left rectus muscle, a greatly distended transverse and descending colon were immediately encountered. They seemed to fill the greater part of the abdomen and to push the rest of the intestines backward and to the right. The splenic flexure was held in position by its peritoneal attachment, the costo-colic ligament, and formed an acute angulation. The distention seemed largely due to gas.

The descending colon and the splenic flexure were mobilized by dividing their outer leaf of investing peritoneum. The mesocolon was then divided in sections from the lower sigmoid to the hepatic flexure. The liberated loop of intestine, somewhat over forty inches in length and four inches or more in diameter, was then drawn outside of the abdomen through an intramuscular incision which had been made for that purpose above the left anterior superior iliac spine. This brought the hepatic flexure into contact with the lower sigmoid without undue tension. The afferent and efferent intestinal walls were stitched together within the abdomen to aid in proper "spur" formation. The median wound was then closed and sealed. The intestine at the place of exit was secured to the abdominal wall. Temporary circular ligatures were applied to it outside of this exit and the loop of colon beyond the ligatures was ablated. The ablated portion was 95 cm long and held four litres of fluid when injected.

She showed considerable shock and reaction after her operation, but finally rallied satisfactorily. The temporary circular ligatures were removed from the protruding stumps of intestine after forty-eight hours and a "double-barrelled" intestinal stoma was thus established.

The median incision healed by primary union. The clamping of the spur was begun after twenty-five days, and twenty-three days later the intestinal ends were stitched together at the site of the stoma.

She left the hospital seventy-eight days after the operation. At that time the stoma was firmly closed. She was having normal bowel movements, she had been walking and playing about the ward and the porch for two or three weeks, she ate well, had gained much strength, and five and three-quarters pounds in weight. The X-ray picture shown in Plate No 2, indicates the condition of the remaining colon at that time.

She has been carefully followed during the intervening months. Her digestion has remained normal, and she has normal daily stools. She has gained twelve pounds in weight since she left the hospital, and is now a normal, active, happy, good-natured youngster.

An X-ray picture taken March 7, 1921, shows that the colon has about the same outline as when she left the hospital.

PATHOLOGICAL REPORT

Macroscopic (by Dr W C White)—Specimen consists of a piece of large intestine 95 cm long in transverse diameter, varying from 5 to 7 centimetres. The wall is thin, markedly dilated, pale and of atonic appearance. The mucosa appears normal and the specimen otherwise is unremarkable.

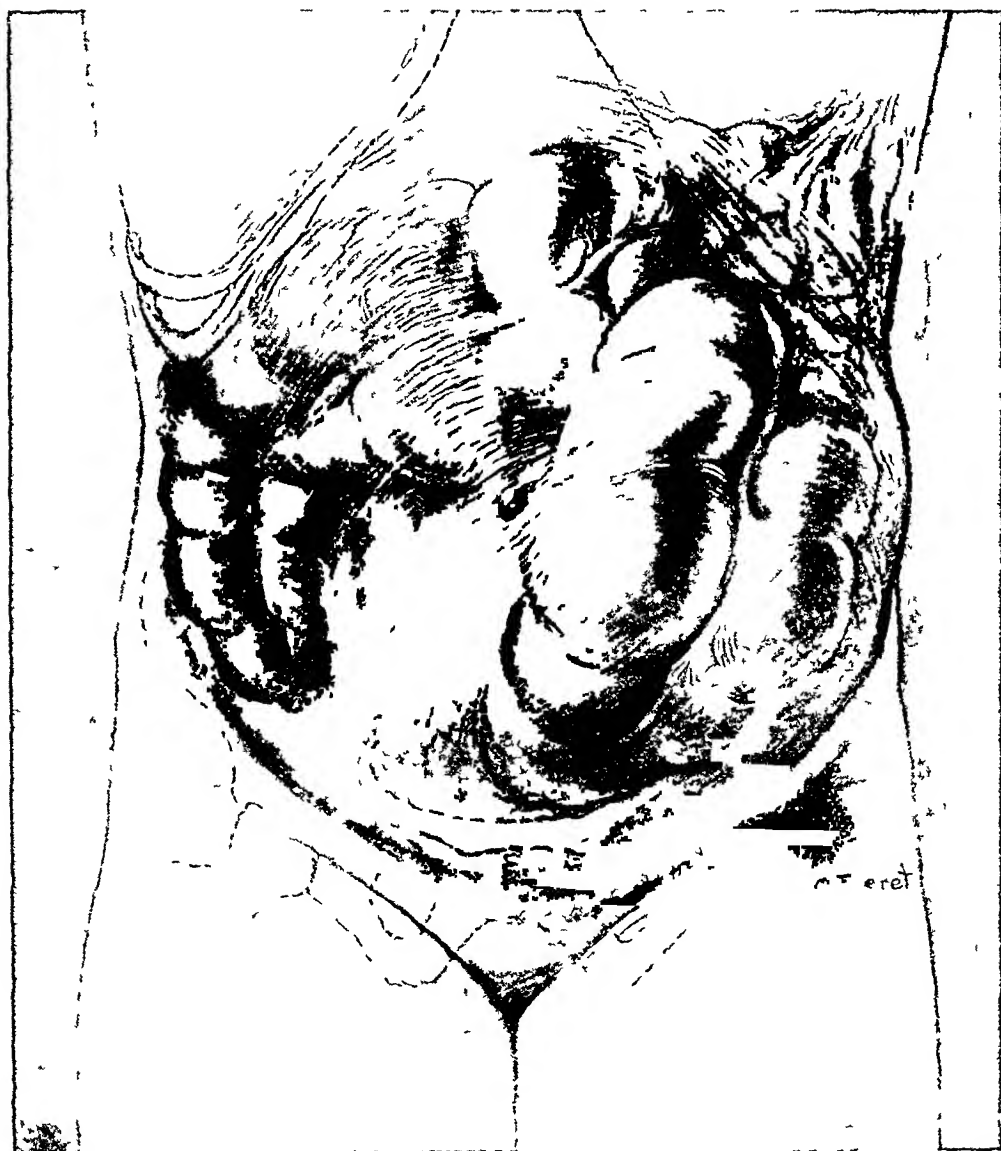


FIG 1 —Diagrammatic drawing showing condition of megacolon in Case I. Colon angulated at splenic flexure. Transverse colon and descending colon and sigmoid flexure greatly distended.



FIG 2 —X-ray picture after enema of barium mixture showing shadow of the descending colon and sigmoid flexure



FIG 3 —X ray picture taken twenty four hours after meal of barium mixture showing condition of colon three months after operation

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Microscopic—The entire wall is very much thinned out. The mucosa is intact and shows no inflammatory reaction. The muscularis mucosæ is very thin. The submucosa consists of relatively loose tissue. The circular and longitudinal muscles are thinned out. The serosa is loose and shows no connective-tissue increase.

CASE II—F W, aged seventeen. Admitted to the Roosevelt Hospital November 6, 1920. History No. 17337 A. She had always been very constipated, has had three or four attacks of great abdominal distention and vomiting during her life. The last previous attack came six months ago, the distention then was almost as great as at the present time. She then had repeated vomiting and severe abdominal "cramps."

The present attack began three weeks ago with abdominal distention, nausea and vomiting. The distention increased and was accompanied by very severe abdominal pains. Repeated enemas had been given, but some of them at least did not return. The bowels, however, had moved two or three times a day much of the time. During the past three days she had many times vomited green offensive material. Had been in bed the entire three weeks and had become very weak.

On admission to the hospital she was emaciated, very feeble, pulse 140, abdomen enormously distended. The outlines of the intestine were visible through the thin abdominal wall, and slowly moving peristaltic waves could be seen. Enemata and rectal tubes were used in an effort to empty the bowel, but they were not successful. Operation was therefore done.

Through an incision in the lower part of the left rectus muscle an enormously distended sigmoid flexure was found. It was about as tense and thick-walled as an ordinary large ovarian cyst. It could be traced from the pelvis to the upper left angle of the abdomen, but satisfactory examination of the colon beyond that point was not practicable. A suction trocar withdrew semi-solid feces. A purse-string suture was placed about the trocar wound. The abdominal incision was closed except an opening of one and a quarter inches, the intestine outside the purse-string was stitched to the edges of this opening, a flanged glass tube was introduced within the purse-string and secured in its position. About one gallon of fecal material was then drawn through the tube by a suction apparatus. During the following forty-eight hours about another gallon of fecal material drained away. The abdomen became flat, its circumference was reduced from thirty-four inches to twenty-six and a half inches.

For a few days she showed some recuperative power, but died on the sixth day after her operation, apparently with a low grade of pneumonia. She showed no signs of peritonitis. Autopsy was not allowed.

CASE III—J C, aged forty-two. Admitted to the First Surgical Division of the Roosevelt Hospital, April 21, 1921. He had suffered from various forms of digestive disturbance during much of his life. Appendicectomy was done in 1909. Gastro-enterostomy was done in 1912. He had then enjoyed reasonably good health until two weeks before admission to the hospital when he had an attack of bronchitis or broncho-pneumonia. Sixty hours before admission he was seized with very severe general abdominal pain—"doubled up with the cramps." Vomited repeatedly—attacks of vomiting and pain have both continued until the present time. Constipation "very bad" for the past two weeks. Bowels did not move without catharsis, and then only in small quantities. Much worse since pain started. No gas per rectum. When admitted to the hospital he seemed weak, thin, very ill, and in much pain. His abdomen was distended, there was much muscle spasm, and dullness at its lower part. Peristalsis waves were visible.

Operation—Four-inch incision in right rectus, enlarged to six or seven inches. Abdominal contents under much tension. Small intestine collapsed and appar-

ently empty throughout its entire extent. In the left side of the abdomen extending from the diaphragm into the pelvis there was an enormously dilated portion of the large intestine. In order to deliver this it was necessary to remove the small intestines from the abdomen. They were temporarily confined in warm moist towels, the distended colon was then found to extend from the ileo-cæcal valve to the beginning of the transverse colon, it was delivered with considerable difficulty. The large intestine below the middle of the transverse colon was not dilated. The constriction seemed to have been caused by hinging of gut at the middle of the transverse colon. The entire ascending colon had been transferred to the left side and had become enormously dilated in that position. An effort was made to push the gas downward from the dilated intestine. This was only partially successful although no definite band of constriction could be found, A rectal tube was inserted through the anus to aid this procedure. The outer layers of the dilated intestine were dark in color and the wall had broken down in several places. It was therefore deemed wiser to leave it outside the abdomen than to make further efforts to return it. The wound was therefore closed in layers to the emergence of the intestine. The distended intestine was then punctured with an aspirating trocar and a large amount of gas withdrawn, also some very foul-smelling fecal material. The afferent and efferent legs of the intestine were sewed together. The intestinal wall was stitched to the skin. Wound was smeared with sterile vaseline. The ascending colon which was still somewhat dilated was left in the dressing and the patient returned to bed in this condition. After two days a part of the protruding intestine was excised and sent to the Pathological Laboratories.

PATHOLOGICAL REPORT

Macroscopic specimen consists of an opened and somewhat dilated cæcum preserved in formalin. It is more or less cylindrical in shape and measures 13 cm in the longitudinal axis and varies from 2.5 to 6.5 cm in transverse diameter across the opened surface. The serosa is rough and has some adhesions. The wall everywhere is thickened measuring in many places 1.4 cm. It is firm and fibrous. The mucosa is smooth and thrown into folds. There are no areas of ulceration, necrosis or hemorrhage. The lumen is patent and varies from 2 to 5.5 cm in transverse diameter.

Microscopic—The mucosa is about the normal in thickness, but the submucosa is greatly increased with newly formed connective tissue. The submucosa is vascular and has a round-cell infiltration throughout. The circular muscle is about three times as thick as that shown in Case I, but the longitudinal is about the same in thickness. The serosa is greatly thickened and shows a chronic inflammatory reaction.

He did well. The wound healed firmly to the emergence of the intestine. Clamps were applied to the spur on May 25th. On May 31st the ends of the intestine were sewed together. At the present time he is still under treatment in the hospital*. He is doing well and is gaining steadily in strength. The stoma is not yet entirely closed.

These three cases illustrate various phases of the problem. Case I shows the good result which may come from the removal of a sufficient portion of the enlarged colon. Case II shows that a patient with this disease may drift along beyond the possibility of relief, either medical or surgical, and that this drifting may occur while she is trying to attend to the ordinary duties of life. Cases I and III both illustrate the comparative safety of

* Later note. He left the hospital in good condition with stoma entirely healed July 20, 1921.

THE SURGICAL TREATMENT OF MEGACOLON

the extraperitoneal two-stage method of resection (Mikulicz) The cases, however, are too few for general deductions. They are only to be considered in conjunction with the extensive literature which now exists.

Consideration of Literature—As a starting point it should be stated that this literature gives abundant proof that surgical treatment is more successful than medical treatment For instance, Duval gives 74 per cent mortality from medical treatment, 34 from surgical treatment. Lowenstein 66 from medical, 48 from surgical Ladd has given the following tabulation of 118 cases.

	TOTAL	CURED PER CENT	IMPROVED PER CENT	UNIMPROVED PER CENT	DIED PERCENT
Treated medically	60	12	13	6	67
Treated surgically	58	41	8	3	41

Terry found a mortality of only 27 per cent in ninety-five cases treated by surgery Neugebauer, quoted by Hubbard, referred to 123 cases treated medically with only 1½ per cent of cure

Surgical Treatment—The term surgical treatment is a very elastic one and includes many forms of procedure It is interesting to know how different surgeons have met the problems of this disease, it is also important to know the results of the different forms of treatment which they have used.

A number of tabulations have been made but we know of none which give the statistics of a large number of cases treated by modern surgery Hence, with the aid of Dr Charles W Lester, the literature has been searched for records of operations since 1908, the time of the publication of Finney's

TABLE

Results obtained in 143 cases of Megacolon treated Surgically between 1908 and the present time

	Total	Cured	Improved	Unimproved	Died	Mortality Rate
One stage resection	42	28	3		11	26%
Two stage resection						
Intra-abdominal method	31	23	2	1	5	16%
Two stage resection						
Extra-abdominal method (Mikulicz)	13	11	1		1	8%
Colostomy, cæcostomy, appendocostomy	20	3	4		13	59%
Short circuiting	22	13		2	7	32%
Colon plication	2*	2				
Colopexy	3*	2	1			
Colon plication and colopexy	1*		1			
"Laparotomy"	1				1	
Laparotomy with massage of colon	2				2	
Incision of stricture	1			1		
Release of volvulus	4*	3			1	
Colotomy	1		1			
Total	143	85	13	4	41	28.7%

* Other patients who had secondary operations when these procedures had failed to cure are grouped under "two stage" resections, hence this tabulation does not show the failures of these semipalliative operations

article The search has been carefully made, and without doubt most of the published reports have been found Some have probably escaped notice, but no report which has been found has been omitted One hundred and forty-three cases have been tabulated This includes 136 cases found in the literature, four cases learned of by personal report, and the three cases recorded in this paper

This table shows an improvement in the general mortality rate So far as I know 28.7 per cent is a lower mortality rate than has previously been reported for a large collection of cases, excepting Terry's report of 27 per cent The mortality rates shown in some previous tabulations are here given

	DATE	NUMBER OF CASES	MORTALITY RATE
Lowenstein	1907	44	48
Schmidt	1908	71	48
Duval	1910		34
Schneiderholm	1915	143	36
Ladd	1921	58	41

The improvement seems to be due to the more general use of rational radical surgical procedures The increase of such surgical procedure is strikingly shown in comparing the table given above with that prepared by Schmidt in 1908 (See Addenda) It is noteworthy that although Schmidt's tabulation contained only five two-stage resections intraabdominal and extraabdominal they were all followed by recovery

From a surgical standpoint the cases may be divided into three groups

- 1 Those for whom only colostomy or appendicostomy was done
- 2 Those for whom there was only some semipalliative procedure such as short-circuiting, colopexy, relief of volvulus, colon plication, etc
- 3 Those for whom more or less of the colon was resected

The first group should hardly be considered surgical If patients drift along into semi-moribund condition, and then apply to a surgeon for relief of obstruction, they show the ill effects of whatever treatment they have previously had If the surgeon is magnanimous enough to try to relieve their condition by colostomy he makes a praiseworthy effort to save life, but he has not had a reasonable opportunity of curing megacolon by surgery It is not strange that there was a 59 per cent mortality among the twenty patients in this group That mortality, however, cannot fairly be considered surgical Of course this group does not include those cases in whom the colostomy was the first step in a two-stage operation

Group Two—Semipalliative operations of the type here mentioned were common in the earlier reports In this tabulation they represented less than 26 per cent of the total Surgeons now prefer procedures which give more prospect of permanent cure The mortality rate of this group is 7 per cent higher than for the combined three groups of resections, and the records of "cures" are 18 per cent less Secondary operations were frequently done on patients who had previously had one of these semipalliative procedures, but such cases are recorded under two-stage operations

Group Three—Partial Colectomies—At the present time the main surgical interest centres in the problem of removing as much of the enlarged colon as is practicable and this is the obvious procedure. There are three main methods of doing this.

1 In one stage, removing a portion of the colon and uniting the divided ends within the abdomen either by end-to-end, end-to-side, or lateral anastomosis.

2 Using two stages for intra-abdominal resection. There are many variations of the intraabdominal two-stage method, a preliminary colostomy may provide for washing out the colon before the resection, and may provide a vent afterwards. The cæcostomy or appendicostomy may be done for a vent at the time of the resection. A short-circuiting may be done first and a removal of the excluded intestine later. A release of a volvulus or colopexy or colon plication may be done first and a resection later.

3 An extra-abdominal resection may be done in two or more stages. The portion of colon which is to be removed may be mobilized and delivered outside the abdominal wall before it is opened, preferably through a separate incision, after stitching the intestine to the abdominal wall and closing the primary incision completely and the secondary incision to the point of emergence of intestine, the lumens of the gut are temporarily closed and the desired portion of colon ablated. The continuity of the intestine is later established by removing the spur and sewing the ends of the intestine together.

The dangers of these procedures diminish in the order given. The table gives the mortality rates as 26 per cent for one-stage resection, 16 per cent for intraabdominal resection in two stages and 8 per cent for extraabdominal resection in two or more stages (Mikulicz). These rates may vary with the next table made, but they correspond in fair measure with other statistics.

Each surgeon will endeavor to fit the procedure to the individual case. The proportion of cases of real megacolon which are suitable for a one-stage resection must be small. The main dangers come from sepsis and shock. These colons are particularly foul. No doubt some of them can be so cleansed as to make one-stage resection justifiable, but most of them will need some provision for possible infection or leakage at the site of union and possibly a vent for escape of gas from another part of the intestine. The manipulation incident to a one-stage resection is often more than these patients can endure. A simple time-saving procedure is very desirable.

If operation in two stages is decided upon, each surgeon will again endeavor to fit the procedure to the individual case. Extraperitoneal resection (Mikulicz) is often more tedious and trying to patient, nurse and surgeon than other forms of two-stage operations.

It has never been generally popular, as is shown by the limited number of reported cases. It is, however, becoming more popular and is a very valuable resource, it is doubtful, for instance, if Case I would have survived and obtained so good a result under any other form of operation. It has

the great advantages of rapidity, diminished manipulation of the intestine and diminished shock to the patient. It gives less likelihood of troublesome adhesions. The danger of infection is very greatly diminished since the portion of intestine which is to be ablated is delivered outside the abdomen before it is opened.

It is quite possible that further development of the two-stage intra-abdominal method may meet these advantages, that the colon may be adequately cleansed, that suitable provision for possible leakage at the suture line may be made and that an intestinal vent may be provided which will prevent the accumulation of gas. Also that the patient's strength may be so conserved as to provide a reasonably safe margin for extensive operation.

It is, however, to be remembered that most of these operations are done under adverse conditions. The patients are weak and debilitated, the procedure is an extensive one, the resources of surgery are put to a maximum test and the procedure which gives the least danger must often be selected, even if it implies a more disagreeable convalescence than one would wish. Hence the pro-stage extraabdominal method (Mikulicz) is our safest resource for a larger proportion of these patients.

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ADDENDA

*Schmidt's Tabulation of Cases of Hirschsprungs Disease Treated by Surgery
Prepared 1908 Beitr z Klin Chir Vol lxi p 682*

		Cure	Improved	Not Improved	Died
Expl Lap	11	3	2	1	5
Puncture	4				4
Artificial Anus	10	1		1	8
Colotomy	5				5
Plication	2	1		1	
Colopexy	6	4	1	1	
Anastomosis (short circuit)	16	6	3		7
1 Stage Resection	12	6		1	5
2 Stage Resection	4	4			
Extraabdominal Resection	1	1			
Total	71	26	6	5	34 = 48%

Age of Patients recorded in Table I

Age	Total	Cured	Per Cent	Im- proved	Per Cent	NotIm- proved	Per Cent	Died	Per Cent
Under 6	27	10	40%	3	12%			12	48%
6—10	17	10	59%			2	12%	5	29%
11—20	21	16	76%			1	5%	4	19%
21—40	37	27	75%	3	8%	1	3%	5	14%
41—60	22	15	68%					7	32%
Over 60	11	4	36%	1	9%			6	55%
Not Stated	8	7	87%					1	13%

Cause of Death	Patients recorded in Table I	Number
Peritonitis		16
Shock and Collapse		13
Embolus		4
Pneumonia		2
Hemorrhage		1
Other Causes		5

THE MANAGEMENT OF PELVIC ABSCESS IN ACUTE APPENDICITIS*

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THE lesions of an infected peritonitis of appendical origin are quite analogous to those of the soft parts. This is especially the case in the early stages of infection and it is only after the discharge or removal of the resulting abscess contents that a material difference may be noted. In the soft parts gravity unquestionably dictates the drainage of an abscess cavity at its most dependent portion. On the other hand, satisfactory drainage of abscesses, even of those involving Douglas' cul-de-sac, can be obtained through an opening in the anterior abdominal wall. This apparent contradiction, in the abdomen, of the law of drainage may be accounted for by the fact that the rhythmical contraction of both the thoracic and pelvic diaphragms constantly directs fluid abdominal contents toward any adventitious opening in the abdominal wall as long as the path of communication remains unobstructed. Furthermore, this same movement in the direction of least resistance is favored by the counterpressure resulting from the more or less intermittent involuntary contraction of the abdominal muscles themselves, as well as by the peristaltic activity of the smooth muscle fibres of the intestine. The resultant activity of these different forces comprising intraabdominal pressure accounts for the difficulty frequently experienced in preventing the prolapse of mobile abdominal contents through an operative incision and readily explains the drainage of inflammatory or hemorrhagic abdominal exudate through an opening in the abdominal wall.

This general "law," however, does not apply to all parts of the abdomen alike, for, in the upper part, drainage of the subphrenic spaces through an anterior opening is rarely satisfactory without siphon attachment. In this location the beneficial effect of the peristaltic activity of the small intestine is largely lacking, while the mobility of the adjacent diaphragm is seriously impeded if not entirely suspended by fibrinous exudate, and more especially by the pressure of the accumulated fluid.

Then, too, the overhanging osseous and cartilaginous thoracic wall, together with the adjacent solid and more or less fixed abdominal viscera, prevent the normal contraction and obliteration of the abscess cavity, which is ordinarily so deeply placed that its contents are more likely to be compressed upward against the diaphragm by the contraction of the abdominal muscles than toward any opening anteriorly.

* Read before the American Surgical Association, June 14, 1921

Although quite analogous in their resistance to infections, the fact that the reparative power of the peritoneum is superior to the reparative power of the tissues of the abdominal wall cannot be too strongly emphasized. This is illustrated by the fact that while the discharge from the intraperitoneal portion of an abscess rapidly decreases in quantity and quickly assumes a healthy type, the divided tissues of the abdominal wall regularly undergo appreciable and occasionally extensive necrosis, associated with an abundant foul discharge that continues until healthy granulations are established. This contrast in the relative reparative power of the peritoneum and abdominal wall is perhaps most striking where, after the removal of an acutely distended but not perforated gangrenous appendix, the abdominal incision is closed without drainage. Although, in many of these cases, infection occurs in the suture line, the underlying peritoneum ordinarily escapes. The reparative power of the peritoneum is also well illustrated in one of the cases of this series in which, after the evacuation of an appendix abscess of some days' duration, a loop of small intestine forming the wall of the abscess cavity was found to have so extensively sloughed as to require resection with an end-to-end anastomosis. Prompt healing occurred without the slightest indication of an intestinal fistula, the adjacent pelvic abscess being drained in the usual way.

Drainage of pelvic abscesses by the suprapubic route exclusively does not meet with universal approval. One year ago MacLaren, in a paper read before the American Surgical Association, advocated supplementing abdominal drainage with a counteropening through the rectum or vagina, such an opening, at times, immediately preceding the abdominal incision. In this paper he referred to the recently published report, by Rullison, of all cases operated on at the Presbyterian Hospital, New York, in 1916, in which no instance of this method of drainage was employed, with the comment that by its use in appropriate cases the mortality of 91 per cent might have been materially reduced.

Statistics such as Rullison's are always interesting although, because of the inevitable differences in the operative and post-operative methods employed by different surgeons in the care of these patients, conclusions may prove very misleading. Such statistics, however, serve a useful purpose in providing an opportunity to judge the relative value of different methods of treatment and they should always be collated and arranged with this end in view. On the other hand, deductions based on a series of cases such as MacLaren's, in all of which the principles of treatment were identical, are not only interesting and valuable but highly instructive.

The fact that the writer has never utilized a counteropening through either rectum or vagina in the drainage of a pelvic abscess complicating acute appendicitis is in such marked contrast to the experience of MacLaren that it seemed to justify the further consideration of this subject. With this object in view the writer has made a careful study and analysis of the treatment and results of 351 cases of this lesion that have come under his personal observation during the past twenty-one years (of which 314 are taken from

the records of the Presbyterian Hospital) From this series are excluded a number of fatalities in desperate cases which scarcely survived the operation twenty-four hours and in which no form of drainage could have exercised any favorable effect In this series of cases the gross pathology has varied according to the duration and type of the infection as well as the location of the appendix

Prior to perforation, an abundant, odorless, occasionally turbid fluid exudate has been found, free from pathogenic organism and reparative in character In this group of cases primary union was frequently obtained either without drainage or where precautionary drainage for thirty-six hours only was employed Occasionally infection of the suture line developed and rarely the escape of a purulent odorous collection on the withdrawal of the drain at the end of thirty-six hours necessitated its replacement After perforation has taken place the exudate changes into foul, fetid pus, and, irrespective of the location of the appendix, drainage in these cases is always required If the appendix overhangs the pelvic brim, pelvic abscess is inevitable If the appendix is retrocaecal, pelvic abscess is not infrequent, although there may be no apparent connection between it and the abscess about the appendix It is quite evident, therefore, that in all cases in which the peritoneal cavity is opened for the removal of an acutely inflamed appendix the pelvis should invariably be searched for pus Only in those cases in which a perfectly walled-off abscess may be opened without entering the peritoneal cavity should this search be omitted In this latter group (no cases of which are included in this paper) the efficacy of anterior drainage is generally acknowledged

The incision adopted in the treatment of this series of cases has been invariably the intermuscular This has served both for the removal of the appendix and the drainage of the pelvic abscess The splitting of the muscle in preference to its division conserves the muscle strength of the abdominal wall, favors an early return of its power to contract and materially contributes to the restoration of normal intraabdominal pressure These forces together tend to check a spreading intra-peritoneal infection and serve to conduct the flow of the purulent discharge to the drainage opening in the abdominal wall By the use of this incision the wound heals more quickly and firmly with less chance of the development subsequently of a ventral hernia Should such a hernia develop, its repair is both simple and satisfactory

Attention to other operative details materially promotes the efficiency of subsequent drainage

The removal of the appendix, and consequently of the source of infection, the insertion of a purse-string suture or, when that is impossible, the reinforcement of the appendix stump by the superposition of an omental flap, the minimum handling of the small intestine, the thorough evacuation of the pelvic abscess and the careful cleansing of the cul-de-sac with saline irrigation are important steps of the operation The pelvis is irrigated with the shoulders of the patient elevated, the intestinal loop being held gently aside

PELVIC ABSCESS IN ACUTE APPENDICITIS

TABLE I

Date	Type of drainage	Replacement drainage	Number of cases	Irrigation through primary drain	Average number of days, cured		Complications								Cured		Died		Secondary abscess, case number	
					Uncomplicated	Complicated	Complications only	Rectal fistula		Phlebitis		Respiratory		Secondary abscess		Actual	Per cent	Actual		Per cent
Jan, 1900- Nov, 1900 Nov, 1900- Feb, 1904	(a) Mikulicz, (b) sterile gauze, iodoform gauze or (c) Iodoform gauze or sterile gauze and rubber tube, (d) Mikulicz rubber tube (e) Rubber tubes, (f) rubber tubes and gauze wick	Gauze packing Same as original	39	0	32	38	55	4	10	2	5	1	2.5	0	0	32	82	7	18	8138
			39	±	28	32	44	4	10	1	2.5	0	0	2	5	32	82	7	18	8179
Apr., 1901- Mar, 1905	(a) Rubber tubes, (b) rubber tubes and gauze wick	Cigarette or rubber tube	24	+	27	31	44	7	29	0	0	0	0	0	0	22	92	2	8	
May, 1902- Nov, 1908	Cigarette only	Same as original	33	0	24	24	30	1	3	0	0	0	0	0	0	32	97	1	3	
Nov, 1908- Feb, 1904- Dec, 1904	Rubber tube and cigarette	Same as original or rubber tissue	7	+	26	27	32	1	14	0	0	0	0	0	0	7	100	0	0	
Jan, 1905- 1907	"Collar" cigarette	Cigarette	27	0	25	26	37	2	7.5	0	0	0	0	1	4.7	24	89	3	11	5135
Mar and Apr, 1912	Rubber tube and cigarette	Cigarette or catheter	3	+	21	21	21	0	0	0	0	0	0	0	0	3	100	0	0	
1908-1912	Cigarette only	Cigarette or rubber tissue or catheter	72	0	20	23	44	4	5.6	1	1.4	1	1.4	5	7	71	98.5	1	1.4	7521 7507 7067 7758 9529 19472 M-43
June, 1911-present	Rubber tube and gauze wick	Catheter	70	+	20	23	41	4	5.7	1	1.4	5	7	2	2.9	68	97	2	2.9	
Total			314					27	8.6	5	1.6	7	2.27	10	3.2	291	93	23	7	

by the pressure of a long, narrow retractor against a previously inserted pad. When concluded, and the pelvis has been sponged dry, the drain is inserted to the bottom of the cul-de-sac before the withdrawal of the retractor and pad. After firm compression of the adjacent abdominal wall and bimanual compression of the right ileocostal space have either excluded or removed all further exudate, the abdominal incision is closed, rather loosely, around the projecting tube with interrupted chromic-gut sutures. The primary abscess cavity, if paracæcal or retrocæcal, is similarly drained through the same opening, or, if situated above the crest of the ilium, through a counteropening in the flank.

For about two years, in the first part of this period, the primary drain consisted of a Mikulicz tampon of plain or iodoform gauze, the incision being only partially closed. The severe pain occasioned by the withdrawal of this drain as well as by its replacement, together with the risk of a prolapse from the rupture of intraperitoneal adhesions (which actually occurred in one instance at the initial dressing five days after operation), led to its being discontinued and to the substitution of a rubber tube enmeshed in gauze. It is quite possible that the use of an investing rubber dam would have eliminated both the physical discomfort and the risks of the Mikulicz tampon. It has never been employed, however, as other methods of drainage have proved thoroughly satisfactory.

In 1902 two or more cigarette drains were substituted for the enmeshed rubber tube, and this method of both primary and secondary drainage was continued for ten years. During this same period the combined use of a cigarette drain and rubber tube was occasionally employed, and for three years a cigarette drain inserted through a rubber tube equal in length to the thickness of the abdominal wall was quite generally used. This rubber "collar" was designed to facilitate drainage by preventing too sudden approximation of the separated muscle planes.

In 1911 laboratory investigation demonstrated that capillary drainage by means of a cigarette drain was practical for the serous but not for the cellular part of purulent material, and that within a few hours its drainage value became greatly impaired even for serous discharge. This method was therefore discarded, although it had generally given satisfaction, in favor of the simple rubber tube containing a narrow wick of gauze projecting slightly at either extremity, in order that whatever advantage might accrue from the use of capillary drainage in the first few hours after operation might be retained. The withdrawal of this form of primary drain as well as that of the tampon and cigarette drains, at the end of four or five days, invariably releases an appreciable amount of pent-up purulent material which with ideal drainage should have previously escaped into the dressing. It has further been learned that this undesirable blocking of the discharge can be avoided only by the removal of the drain within the first thirty-six to forty-eight hours after the operation. That such a simple remedy was not immediately adopted was due entirely to the difficulty experienced in the

TABLE II

SECONDARY ABSCESSSES

Date	Case No	Type of drainage	Replacement drainage	Postoperative development (day)	Location	Amount	Character of pus	Treatment		Result	Operative findings	Autopsy findings
								Incision	Spontaneous rupture			
Feb., 1902	8138 (A W)	Mikulicz and two rubber tubes into pelvis	Same	14-21	Pelvis	2 oz	Different from abdominal pus			Died 23 d		Pelvic abscess about 202, general peritonitis purulent in character and of a different character from pelvic abscess
June, 1902	8179 (H S)	Mikulicz and rubber tube	Same	4	Pelvis	1 pint	Thin	At dressing a drain up death nine hours later	loop of gut into wound, and a half	Died 5 d	Finger in pelvis entered a cavity containing 1 pint of thin pus, no lunks or obstruction of intestines	
April, 1907	5135 (M C)	"Collar" cigarette	Same	7	Behind and to left of rectum	1 oz	Foul	Exploratory, ileostomy and drainage		Cured 51 d	Small intestines of dull color, fibrous flakes, a distinct band in iliac fossa, constricting gut, abscess and foul pus	
1908	7521 (E M)	Cigarette	Same	5-7	Abdominal wall, right lumbar	1 oz	Yellow	Right flank		Cured 29 d		
1908	7507 (J B)	Cigarette	Same	12-17	Peritoneal left lower quadrant	2 oz	Streptococcus	Left lower quadrant		Cured 44 d	Mass not palpable per rectum	
1909	7967 (J W)	Cigarette	Same	7	Left iliac fossa into pelvis	2 oz	Streptococcus	Left rectus		Cured 27 d		
1909	7758 (K D)	Cigarette	Same	12-19	Abdominal wall left lower quadrant	+	Streptococcus and colon	Left lower quadrant		Cured 34 d		
1909	9529 (W G)	Cigarette	Same	12-17	Pelvis	++				Cured 40 d		
1914	19472 (F)	Rubber tube and gauze wick	Catheter	20-38	Subphrenic	3 oz	Streptococcus and colon	Original incision enlarged (McBurney)		Cured 60 d - 21 d		
1914	(M-43)	Rubber tube and gauze wick	Catheter	8	Above and to outer side of cecum	+				Cured		

insertion of the replacement drain before the end of the fourth or fifth day—a difficulty that was eventually overcome by the use of a Nelaton catheter. The rounded extremity and the flexibility of this instrument facilitate an easy, painless passage along a recently formed sinus leading into an abscess cavity, while the fact that the gauze in which its extremity is invested is stained at some distance from the edge of the incision with discharge conclusively demonstrates its value as a drain. At each dressing the character of the discharge from the deepest part of the abscess cavity can be determined by compression of the extremity of the catheter just prior to its withdrawal, and by the use of similar siphon action the entire abscess tract can be rendered practically dry after irrigation. The only reason why the catheter is not used as a primary drain is that, on account of its very flexibility, the passageway leading into the cul-de-sac would probably be much more sinuous (and therefore less suitable for the effective discharge of the abscess contents) than the much straighter channel secured by the use of a relatively unyielding rubber tube for the first thirty-six or forty-eight hours. The catheter, then, is used both as a drain and for purposes of irrigation, the latter begun four days after operation and continued until the offensive character of the discharge disappears. At the end of eight to ten days the intraperitoneal part of the sinus is practically obliterated and the closure of the superficial wound follows in a few days. To sum up, the establishment of a direct passage into the deepest part of the abscess cavity is obtained by the use of a medium-sized rubber tube for thirty-six hours, and the continued unobstructed patency of this passage is secured by the daily introduction of a Nelaton catheter. So satisfactory has this method of drainage proved that its use has been extended to the drainage of infectious processes in all parts of the abdomen with equally good results.

While the value of effective drainage in these cases must not be minimized, the ultimate closure of the abscess tract is unquestionably hastened by irrigation. As this practice has become more and more a matter of routine, the average duration of healing has progressively decreased from thirty-two to twenty days. Irrigation also contributes to the comfort of the patient by mitigating the offensive character of the discharge.

The fatalities occurring shortly after operation in this series of cases must be ascribed to the intensity and extent of a far-advanced peritonitis which in no way could have possibly been diminished by any method of drainage. A study of the results obtained in all other cases seems to justify the conclusion that drainage through a rectal or vaginal counteropening would not have affected materially the mortality. To this statement exception should be made in two instances in which the Mikulicz tampon was employed. In one, twenty-three days after operation, an autopsy showed a collection of two ounces of pus in the pelvis, markedly different in its appearance from the generally distributed purulent exudate of associated diffuse septic peritonitis, in the other, a loop of small intestine prolapsed on the fourth day after operation at the time of the initial withdrawal of the tampon. A

PELVIC ABSCESS IN ACUTE APPENDICITIS

rapidly developing peritonitis then led to a secondary laparotomy with the discovery of at least a pint of thin pus in the pelvis. The patient did not long survive the operation.

In cases drained by cigarette drain, between 1902 and 1912, secondary abscesses developed in five cases. These appeared as early as the fifth and as late as the nineteenth day after operation. The location of the abscess in one instance was the neighborhood of the gall-bladder,* in another, in the right lumbar region, in two instances, in the left lower quadrant near the anterior parietal peritoneum, and in the remaining three, in the left side of the pelvis—in only one of which was the abscess palpable through the rectum.

Six of these secondary abscesses were opened through an anterior incision. In one, the abscess discharged spontaneously into the original abscess tract. All recovered, and in only one patient—in whom, in addition to an abscess in the left side of the pelvis, the small intestine had become constricted by a fibrinous band—was the condition serious. A prompt recovery, however, followed the evacuation of the secondary abscess and an ileostomy for the relief of the obstruction.

Since 1912, during which period primary drainage by a rubber tube containing a small wick of gauze has been employed, two instances of secondary abscess have developed—one above and to the outer side of the cæcum, and the other in the right subphrenic space. In both, recovery followed the evacuation of the pus through an appropriate incision. There has been no instance of the formation of a secondary abscess in the pelvis.

Of all secondary abscesses complicating appendicitis those occurring in a part of the abdomen remote from the pelvis must be ascribed to failure to remove all infectious foci, and it is reasonable to infer that those appearing in the left lower quadrant near the anterior abdominal wall are due to a similar cause. Those occurring in the deeper part of the pelvis, especially where an elastic swelling can be palpated through the rectal wall, probably indicate defective drainage. In those that have no connection with the original drainage tract the cause may at least be said to be doubtful.

Further valuable evidence of the efficiency of pelvic drainage is derived from the results of two autopsies occurring respectively thirteen and eleven days after operation. In the first instance drainage by means of collar cigarette, and in the second instance two cigarette drains had been employed. In neither was any accumulation of pus found in the pelvis. The case reports also show four instances of secondary enterostomy done six, seven, six and six days, respectively, after the primary operation. In one, already referred to, there was a collection of pus on the left side of the pelvis near the rectum, having no communication with the original drainage tract. In the remaining three the pelvis was entirely free from purulent exudate. In three of these cases a collared cigarette drain and in the fourth a rubber

* Not included in table

TABLE III
CASES REQUIRING SECONDARY OPERATION—NOT FOR ABSCESS

Date	Case No	Primary drain	Secondary drain	Type of operation	Operative findings	Result	Autopsy findings
June 1900	7735 (E M)	Iodoform gauze	Same on second day	Exploratory median incision on fourteenth day	Considerable serum in general cavity, no odor and no pus, intestines congested. Intestines somewhat congested, were separated till bottom of pelvis was exposed, no abscess, a Mikulicz tampon of iodoform gauze to pelvis	Died on twenty-first day	
Dec., 1901	8086 (M B)	Mikulicz and rubber tube wrapped in iodoform gauze, no pelvic abscess	Same	Exploratory median incision on fourth day	(c) Serous fluid in pelvis without odor, kink in small intestine relieved, no special relief (b) At first great relief through free evacuation both through fistula and rectum	Died on fifth day	
Mar., 1906	1960 (A F I)	'Collar' cigarette		(a) Intestinal obstruction on fifth day. (b) enterostomy second day	Small amount of free serous fluid, the walls of small intestines showed a number of fragments of plastic material. Exploration of pelvis showed no accumulation of pus	Died on eleventh day	Around stump of appendix no sign of either ligature, a small black, sloughy fistula 4½ feet above valve, no gangrene in either large or small intestine
Nov 1907	5596 (A B)	Cigarette to pelvis, collar cigarette to iliac fossa	Fourth day, all out	Ileostomy on sixth day, first incision, left ileocolic space, second incision, midline above umbilicus		Cured by third day	
1909	9772 (S H)	Cigarette	Gauze packing because of hemorrhage	Twelfth day, considerable hemorrhage after dressing		Died on thirteenth day	Small pockets of pus between matted coils of small intestines, no collection of pelvic pus, tubes and ovaries normal

tube containing a small wick of gauze had been used. The sole fatality occurred in one of the cases drained by a collared cigarette.

Analysis of the evidence presented by these different conditions justifies the conclusion that, with the exception of the two cases treated by Mikulicz tampon and two instances of secondary abscess in the deeper part of the pelvis, the drainage of the cul-de-sac has been satisfactory. It is at least not too much to state that during the past ten years, since the inauguration of the present method of drainage, the absence of a single instance of secondary formation of abscess in the pelvis seems to exclude the need of the use of a rectal or vaginal counteropening.

The possibility of inefficient drainage either of the cul-de-sac or of some contiguous part of the pelvis, however, must always be kept in mind. To forestall surprise, a daily leucocyte count should be taken and a rectal examination should be made at least once in forty-eight hours in search of tumefaction or tenderness. It is both interesting and important to note that usually both of these symptoms may be elicited. The tenderness, however, is decidedly less than prior to the operation, and the sense of swelling—the result probably of the matting together of intestine and omentum—gradually subsides and entirely disappears in the course of a few days.

By one without experience in the use of rectal or vaginal drainage, any criticism or discussion of its value is out of place. Perhaps the possibility of the entrance of additional causes of infection through such an opening may be advanced as a theoretical objection. Furthermore, the possibility of a persistent sinus must not be overlooked. Finally, if vaginal section in the treatment of pyosalpinx in any criterion, the possibility of inadequate drainage through a vaginal opening must be recognized. The writer also apologizes for suggesting that the evacuation and drainage of a secondary pelvic abscess deeply seated in the cul-de-sac, in the absence of any indication of a spreading peritonitis, could be advantageously carried out through the rectum or vagina rather than through a fresh incision in the anterior abdominal wall.

In conclusion, the writer presents this method of drainage of pelvic abscess in full knowledge of the fact that numerous surgical lesions admit of satisfactory treatment in one of several ways, and with no intention to exclude other methods of treatment which in the hands of his colleagues may have yielded equal if not superior results.

ON THE MECHANICS OF PRODUCTION AND THE TREATMENT OF SPIRAL FRACTURES*

By EMMET RIXFORD, M D

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THE problem presented by spiral fractures of the long bones is one of special importance, first because of the great frequency of these fractures, and second, because the anatomical and functional results of their management by the usual technic leave much to be desired

Figures differ as to the relative frequency of spiral fractures because of more or less uncertainty as to the definition, *ie*, in addition to pure torsion fractures there are mixed forms in which torsion may be active in the production of the fracture but plays a relatively small part, and again there are opportunities for difference of opinion as to what proportion of the so-called oblique fractures may properly be classified as spiral fractures

For purposes of the present paper only those fractures are called spiral which are typical and are the result of torsion Stinson (Edition 1912) says spiral fractures are rare, Scudder (1911) does not mention them, Zuppinger estimates that 26 per cent of all fractures of the tibia are spiral and 39 per cent of all fractures of the shaft of the tibia Probably these figures are low

That the results of the treatment of spiral fractures by the process of reduction and fixation, and even by traction, are unsatisfactory anatomically, and functionally may easily be seen and will as readily be admitted by almost any clinician who will carefully criticise and check up his results Non-union is frequent in spiral fractures of the lower third of the tibia, irregularity of the bone in case of union is the rule with a persistent and symptom producing external rotatory deformity in the majority of cases with frequent anterior flexion deformity and more or less shortening We often see abduction deformity as well, sometimes of sufficient degree, especially when associated with external rotation to be the cause of breaking down of the arch of the foot with resulting pronation and flat-foot

A proper understanding of spiral fractures and the special difficulties of their management must rest on a clear conception of the mechanism of their production Fortunately this is not difficult, though it receives scant attention even in our better texts

That spiral fractures of the shafts of the long bones are the result of torsion has long been known and abundantly proven both clinically and experimentally—witness the unusually interesting case of Doctor Monks of this association in which no force other than torsion was active In this case two men were sitting with forearms flexed to a right angle, elbows on a

* Read before the American Surgical Association, June 14, 1921

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table between them, striving by pressing their palms together to see which could force the other's hand to the table, thus producing powerful external rotatory stress on each humerus. One humerus gave way, breaking in a spiral. Precisely the same thing occurred in a personal case in which the right humerus gave way in a left-handed spiral fracture as a result of violent effort in throwing a base-ball.

If a fracture is produced by a mechanism so simple that it can be followed and analyzed one would expect the form of the fracture to be typical under the laws of pure mechanics. These conditions obtain most perfectly in the case of spiral fractures where not only the general form of the fracture, but also the direction of the spiral is determined by and corresponds to the direction of the axial rotation. Moreover most of the clinical phenomena pre-

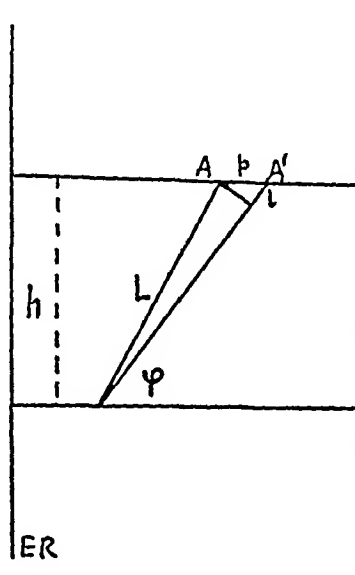


FIG 1 —After Zuppinger

sented by spiral fractures are such as necessarily must obtain as a consequence of these mechanical relations.

The fundamental principle determining the direction of the spiral and the pitch were worked out by Zuppinger (*Brit & Chir* 1906, lii, 391, and 1909, lxiv, 562), applying Hooke's law to the effect that the lengthening of a given bar of any material under tensile stress is proportional to its original length and to the tensile force active in producing the lengthening. If a bar of any cross section, *e g*, a cylinder of length h is subjected to axial torsion, and if L be the length of any line drawn *ad libitum* on its surface, the effect of the torsion is to move the point A to some point A' in the direction of the torsion, l would then be the amount of lengthening of L resulting.

The following equation would represent the relations

$$S \equiv a \frac{l}{L}$$

in which S is the tensile force and a some constant depending on the nature of the material. By simple algebraic substitution it is evident that

$$S \equiv a \frac{P}{h} \sin \phi \cos \phi$$

for small values of ϕ S is a maximum where sine and cosine are equal, *i e*, at $\phi = 45^\circ$

From this it follows that the more brittle the material the nearer the angle approaches 45° . Thus if one twists axially a chalk crayon, a material approaching the limit of brittleness, he finds that it breaks consistently in a spiral of almost exactly 45° pitch, two limbs of the spiral being connected by more or less longitudinal fracture.

The material in giving way breaks at right angles to the direction of the tensile force. Therefore a bar subjected to left-handed torsion, as in the figure, breaks in a right-handed spiral and, *vice versa*, right-handed torsion causes left-handed spiral fracture.

Since in less brittle material there is a greater yielding or stretching under tensile stress—in this case torsion—the angle ϕ is small, consequently the pitch of the spiral fracture is steeper, thus in the long bones of children, spiral fractures are much more oblique than in adults, which accords with clinical experience—extreme cases occurring in which the spiral fractures are almost longitudinal fractures. It thus follows that in children many spiral fractures are capable of practical adjustment without open operation.

The effect of torsion may readily be illustrated by cutting a piece of rubber tubing in a spiral manner and then twisting it axially—a right-handed spiral will be opened up by a left-handed torsion and per contra a left-handed spiral will be opened up by a right-handed twist.

The almost universal finding clinically of left-handed spirals in the right upper and lower extremities and right-handed spiral fractures in the left upper and lower extremities is the result not of any particular characteristic of constitution of the bones in question, but purely of the mechanical necessities of the case, a measure of the overwhelmingly greater frequency with which the extremities are subjected to external rotation rather than internal.

It is but a coincidence that in the development of the extremities a rotation occurs in the long bones in the sense of internal rotation which is supposed by some to produce a sort of spiral grain in the bones (Fleming). Witness the backward position of the feet in the so-called siren deformity where internal rotation is inhibited by fusion of the fibulæ. Here the spiral development of the femora continuing, the upper end of each femur gives way in an anterior congenital dislocation of the hip (Dreesmann).

If a right femur or humerus be subjected to internal rotatory stress sufficient to break it, *e g*, right-handed torsion, a right-handed spiral fracture will result in spite of any left-handed spiral grain to the contrary, and this right-handed spiral fracture will be identical, except for the reverse direction of its spiral, with the usual left-handed spiral fracture of the right femur or humerus.

The spiral fissure may extend completely around the full circumference of the bone even more than once. In the case of the young man who broke his humerus throwing a base-ball, the spiral fissure when exposed in open operation was traced at least twice around the bone.

Since in a given case of torsion effective in breaking a long bone the whole bone is under stress in an infinitude of potential spirals, determination of the particular spiral in which the bone is about to break is quite fortuitous,

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depending simply on the location of some weakest point. Of course this is ordinarily single, but it is not a very violent supposition to conceive that there may be two or more weakest points so nearly equal that the bone may break in two or more parallel spirals. With this idea in view, and after hunting for some years, I finally found a case of spiral fracture of the tibia with parallel spiral fissure in a young adult. Of course others have found similar cases. Recently my associate, Doctor Rumwell, found one with two parallel spiral fissures in a girl of twelve in the Stanford out-patient clinic and Doctor Blaisdell, of the Stanford Medical School, succeeded in producing by pure torsion parallel spiral fractures in the humerus of a cadaver.

If the torsion force acts no farther the bone is merely spirally fissured, it is not actually separated into two fragments. Precisely this fracture does occur occasionally in young people as is proven by the X-ray.

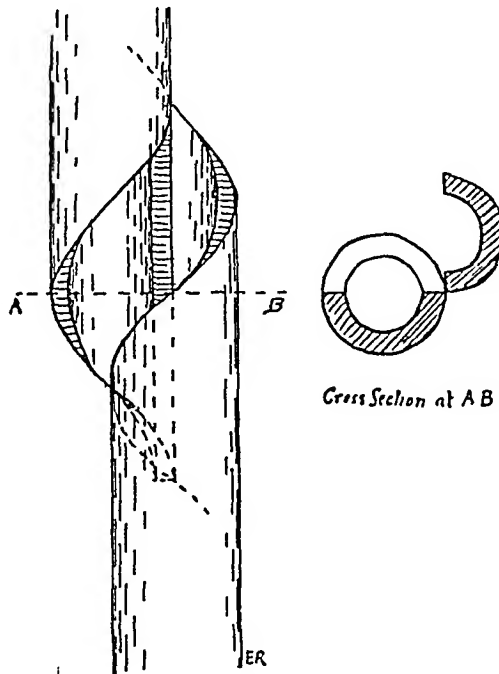


FIG 2 —Right handed spiral fracture with fragments rotated to 90°

It is not necessary to invoke other forces such as bending moment as does Zuppinger to explain the occurrence of the vertical component of spiral fractures, for this part of the fracture by which the bone is separated into two fragments necessarily follows from continuance of the torsion.

That bending moment, however, has some effect in determining the particular location of the fracture is probable as offering an explanation (Zuppinger) of the fact that in the majority of instances of spiral fracture of the tibia, the spiral component of the fracture is ordinarily on the anterior aspect of the bone and the longitudinal component behind.

If the torsion force continue after the bone has given way in spiral fissure an entirely different distribution of forces instantly takes place. Tensile forces develop on the inner surface of the bone and compressive on the outer, as may readily be seen by reference to the diagram (2). The bone

forces now active on its inner surface, it breaks in a nearly longitudinal fracture, folding outwards on its external surface and on the periosteum as a hinge. This longitudinal fracture connects two adjacent limbs of the spiral completing the separation of the bone into two fragments. Since the spiral fracture precedes the longitudinal, the spiral fissure is ordinarily found to extend a considerable distance at one or both ends beyond the point of intersection of the longitudinal element of the fracture.

Since the bone is pulled apart along the spiral element of the fracture the periosteum is uniformly torn along this line, and because in the production of the longitudinal component of the fracture the bone is folded towards its outer surface, the periosteum is not torn along that part of the fracture. This fact is of the greatest clinical significance as will be seen farther on.

Along the spiral part of the fracture, however, the periosteum, as said above, is torn, more than that, it is pulled apart and therefore torn irregularly, leaving numerous tabs which fold around the fracture surfaces, and if not removed or replaced militate against union much as similar tabs of aponeurosis do in transverse fracture of the patella.

By reference to the diagrams again it may readily be seen that in the process of disengaging the tips of the fragments in the instant of completion of the fracture, their sharp points being accurately mortised in their corresponding niches, will frequently be broken off, because the majority of long bones are of substantial thickness between periosteum and marrow, varying of course, but averaging perhaps one-fifth of the diameter of the bone.

So much for the effects of torsion alone. In practice we find that other forces are active in many cases at the moment of fracture and afterwards. Especially is this true in the lower extremities where weight bearing, augmented in its effect by momentum in running or jumping, adds an important element of longitudinal thrust. While it would be interesting mathematically to estimate the effect of such longitudinal thrust in increasing the pitch of the spiral by adding shearing stress, this effect is unimportant clinically. Much more important is the effect of longitudinal thrust if active after fracture is complete and the fragments rotated as described above. For by this same rotation the fragments are completely disengaged and offer no resistance whatever to longitudinal thrust. Thrust will then cause the fragments to pass by each other and the periosteum on the side of the vertical component of the fracture not being torn apart will be stripped from one or both pointed ends of the fragments but will otherwise remain as a "periosteal bridge." Clinically, one generally finds the tips of the fragments in spiral fractures bereft of periosteum. The fragments under these circumstances are so free to move in any direction that their sharp projecting points and knife-like edges may lacerate muscles, nerves, blood-vessels, neighboring joints, etc., and often perforate the skin, making the fracture compound. In being moved about these long, sharp points often catch between them tough, fibrous tissues such as intermuscular septa as well as nerves and blood-vessels, any of which may effectively prevent reduction of the fracture.

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Moreover the long points of the fragments may be broken off by bending the limb at the point of fracture and this the more easily occurs because the long points are weakened by the fact that the spiral fissures often extend far beyond their intersections with the longitudinal component of the fracture.

From the above considerations and the complicated form of the spiral fracture it is evident that if the fracture is not perfectly reduced there is practically no reduction at all, *i e*, if there is any displacement whatever there is a great deal of displacement. The untorn "periosteal bridge" being attached along the sides of the bone more or less opposite to the spiral component of the fracture is short, and it is made still shorter by the deposition beneath it of chips of bone or blood clot, or if a little time has elapsed

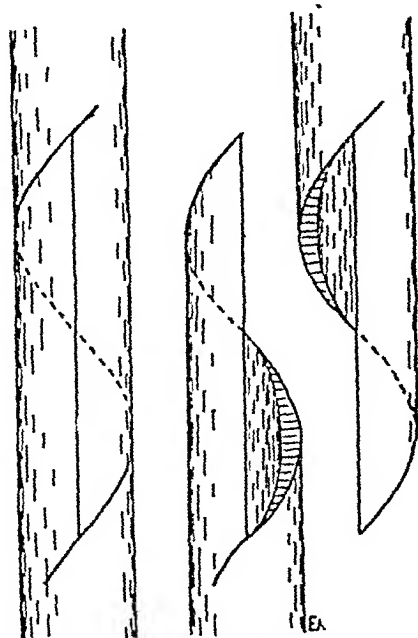


FIG 3 —Right-handed spiral fracture seen from side of longitudinal component

since the occurrence of the fracture by inflammatory tissue or new bone. This short "periosteal bridge" effectually prevents overcoming of rotatory displacement and is one of the reasons for the common clinical experience of the persistence of external rotation after union of a spiral fracture.

From a practical standpoint spiral fractures of the long bones are never reduced except in open operation. But it may be argued that by traction and splinting shortening may be overcome and the fragments may be laid alongside each other, overlapping by their long tongue-like processes, affording sufficient contact to secure bony union. It may readily be seen from the diagrams that unless the fracture is accurately reduced it gapes widely along the spiral component and where contact is established the raw edge of the bone is to a considerable extent in contact with the outer surface of the torn but not stripped up periosteum. A dead space is there present, lined on one side by connective tissue (outer surface of the periosteum),

which may grow into it more rapidly than bone, militating strongly toward non-union

Thus may readily be grasped the reason for the common clinical experience that union begins on the side of the "periosteal bridge," *i e*, on the side of the longitudinal component of the fracture, the intact periosteum furnishing an effective barrier to the ingrowth of connective tissue at this point

On the other hand, when the fracture is accurately reduced the fragments fit with such mathematical accuracy that they afford a very considerable degree of stability. Theoretically in the typical case there is but one direction in which stability is lacking and that is in the direction of the original axial rotation by which the fracture was produced

It would therefore be logical in the management of such fractures to support this weak point. Like accurate reduction of the fracture this can only be accomplished in open operation, but then it can be done most simply and effectively with a minimum of traumatism to the tissues and with a minimum of implanted hardware. There is no need for long plates with many screws

By giving scrupulous attention to the principle of producing a minimum of traumatism, avoiding stripping up of the periosteum and with a good aseptic technic the risk of infection would be minimized, and it would seem that the advantages of securing perfect form and function otherwise impossible would warrant taking that risk. If operation is done early, *i e*, before secondary changes have occurred, the required manipulation is easy and there is no necessity of excessive pulling and prying and tearing the tissues

While not an advocate of operative treatment in fractures in general, or even in any very large proportion of cases, I submit that in my hands I have had far greater satisfaction in view of the results obtained in early operative reduction and fixation of spiral fractures of the long bones than in treatment by traction and external fixation. It is not fair to the treatment of fractures by open operation to have operation relegated to the position of last resort. It should be possible in most fractures to determine before treatment of a fracture case whether proper position can be maintained before with or without open operation. There should be no such thing as operating for mal-union for it can always be determined in the first few days of treatment of a fracture case whether proper position can be maintained before embarrassing secondary changes have occurred

The rapid degeneration of bone under non-use, readily appreciated by following the increase of transparency to the X-rays, militates against later union. It is for this reason, and for the maintenance of joint integrity, that massage of muscles and mobilization of joints is so important in the treatment of fractures. Of greater value than massage and passive motion in maintaining circulation and nutrition of the injured limb is functional demand, a fact that has long been evident from a clinical standpoint, though

not always carried out in practice as systematically as it should be. For the experimental determination of the value of functional demand on the growth of bone I would refer to the beautiful experiments on the bones of young dogs by Doctor Haas, of San Francisco, in which the beneficial effect of early resumption of function is shown in contrast with the findings in an ample series of control experiments ⁺

If fractures of the long bones can be so adjusted and held as to permit early functional demand, non-union will have lost one of its chief causes. In transverse fractures, if the fragments can be set on end and held so, even if the area of contact is but a fraction of their surfaces, the arm and forearm can be used a great deal and in the lower extremity weight bearing may early be established. In spiral fractures if accurately adjusted in early operation and the weak part of the mechanism (the spiral) properly supported a considerable functional demand can be made within a comparatively short time.

In view of the foregoing it would seem to be worth while to attempt to establish a definite technic for the management of spiral fractures, at least those in which the mechanical phenomena can accurately be estimated, and a technic ought not to be difficult to find on which surgeons could agree.

In spiral fractures of the long bones the advantages of the early operative treatment are so great that I would submit that, barring definite contraindications to operation in general, all spiral fractures of the long bones in adults and adolescents and some in children be managed by early open operation and would submit the following as a technic which has given excellent results in my hands.

- 1 Determine the location and form of the fracture by X-ray plates so taken as to locate that part of the spiral portion of the fracture which is opposite the longitudinal component.

- 2 Cut down on this spiral part of the fracture and remove all detached chips of bone and larger fragments, if not required as a part of the splintage, and drill both fragments, if possible, *in situ*, or with a minimum of disturbance of their position, locating the holes at such points as after reduction will make the line joining them lie obliquely to the spiral in such wise as most effectively to resist torsion displacement. In general this line will be transverse to the axis of the bone.

- 3 Pass a stout silver wire through the drill holes.

- 4 Reduce the fracture by traction, rotation and leverage, taking care not to break the bone, lifting out any periosteal or fibrous tabs from between the fragments along the spiral, but taking care not to strip up the periosteum. Draw the wire taut and twist, hammering the ends down against the bone.

- 5 Close the wound and apply some sort of efficient retentive appliance, a properly fitting Thomas splint or plaster-of-Paris cast.

- 6 Remove the retentive appliance frequently for massage, mobilization of the joints and electrical development of the muscles and arrange for the patient to make functional demand at the earliest reasonable moment.

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INEQUALITY OF THE LOWER EXTREMITIES FOLLOWING FRACTURE OF THE SHAFT OF THE FEMUR IN CHILDREN

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THE treatment of fracture of the shaft of the femur in children presents a variety of problems based upon a consideration of conditions peculiar to children themselves, as well as the peculiarities of the fracture. In determining upon the adequacy of a certain method of treatment in a given case it is customary to make such assumptions as that union will take place or that callus formation will be sufficiently abundant to fill such spaces between fragments as in the adult might mean non-union. While the existence of a strong tendency to union and to generous callus formation is commonly appreciated, it is not so commonly appreciated that fracture of the shaft of the femur in children frequently, perhaps commonly, causes stimulation of the growth of the injured bone. In reviewing the final outcome following this injury in children in a series of cases two interesting facts have presented themselves. First, that permanent shortening of the involved extremity was obviously less frequent than following similar injuries in adults, even where at the termination of treatment shortening had existed, second, that it was not uncommon to find some degree of lengthening of the injured leg, this, too, where shortening had existed originally. In fact, excessive lengthening was more common than excessive shortening, and while an undesirable amount of overriding had been modified or corrected by treatment when necessary, there had been no provision included in the usual methods of treatment to prevent or limit excessive elongation of the broken bone with corresponding lengthening of the affected extremity.

A brief description of five cases possessing this lengthening is presented herewith.

CASE I—A P, age nine. Injured August 25, 1918. A fracture of the shaft of the left femur near its centre. Line of fracture irregularly transverse. There was two inches overriding. Under anaesthesia an end-to-end reduction of the fracture was accomplished, apposition being imperfect but satisfactory, and a plaster spica dressing applied. Frequent X-ray examinations indicated that the engagement of the fragments was maintained. There was slight settling upward of the lower fragment, due to absorption under pressure of bony irregularities at point of contact of fragments. At the time of discharge from the hospital, six weeks after injury, one-half inch shortening of the extremity was noted. Two years and two months after injury the affected extremity was found to be three-eighths of an inch long. In the standing position there was obvious tilting upward of the pelvis on this side. There were no symptoms complained of that might be attributed to the injury, no disability.

CASE II—H E, age fourteen. Injured September 27, 1920. A fracture of the shaft of the left femur just above its centre. Line of fracture of the long

FRACTURE OF THE SHAFT OF THE FEMUR IN CHILDREN

oblique variety, with one-half inch overriding Under anæsthesia reduction was attempted and a plaster spica dressing applied One week after injury there was marked increase in the overriding, the extremity shortened one and one-half inches Edmonton tongs with traction applied, the overriding reduced to one-half inch Two months after injury there was one-half inch lengthening of the affected extremity, which at ten months (July, 1921) had increased to one inch

CASE III—C K, age five Injured March 23, 1915 A fracture of the shaft of the left femur, just above its centre The X-ray revealed a comminuted fracture, line of fracture of the long oblique variety, and a large third fragment present There was marked displacement with overriding On the eighth day after injury a Steinmann pin was inserted through the condyles of the femur to correct seven-eighths of an inch shortening Discharged from hospital eight weeks after injury, the extremity one-quarter of an inch short One year and nine months, and again five years and ten months after injury, one-half inch lengthening was observed

CASE IV—P G, age eleven Injured December 5, 1918 Fracture of the shaft of the left femur in its lower third Line of fracture practically transverse with two inches overriding Two attempts under anæsthesia failed to improve displacement of fragments A Lane plate was applied on the twelfth day after injury To obtain reduction and favor end-to-end contact a small portion of bone was removed from the end of one fragment Discharged from hospital nine weeks after injury, the affected extremity three-eighths of an inch short Two years and one month after injury the extremity found one inch long Marked tilting upward of pelvis upon same side in the standing position Lane plate still present and well tolerated

CASE V—V B, age eight Injured May 26, 1911 A fracture of the shaft of the left femur in its upper third Line of fracture practically transverse, just below the lesser trochanter Excessive angular deformity, lower end of upper fragment presenting just beneath skin Other methods failing to bring about satisfactory reduction, a Lane plate was applied on the fourteenth day Small portion of bone removed from lower end of upper fragment to secure reduction and satisfactory apposition Three months after injury affected extremity noted one-half inch short Fifteen months after injury one-half inch lengthening observed Observation seven years after injury and again nine years and a half after injury, showed three-fourths of an inch lengthening of the injured extremity Lane plate still present and well tolerated

Apparently the situation of the fracture is irrelevant in its relationship to the stimulation of bone growth, since overgrowth has been as great in fractures of the upper, middle and lower thirds of the femoral shaft Nor was the epiphysial cartilage directly involved in any case Lengthening may occur whether the method of treatment be by simple reduction, the employment of the pin or the tongs, or the application of a Lane plate, and to an equal degree In four of the five cases there was shortening of the extremity at the termination of treatment, while in two there had been actual removal of bone from the ends of the fragments In none had overriding been over-corrected or even fully corrected While the growth of the fractured bone may be accelerated following its injury, there is apparently no compensatory activity, either early or late, upon the opposite side, and an inequality produced under these circumstances is seen to persist after ten years Evidently the possibility of excessive growth of a fractured femur during the

period of childhood is of sufficient importance to deserve some consideration in the application of treatment to this injury. An extremity one inch short at the termination of treatment would generally be considered a poor result. So far as the patient is concerned it is immaterial whether the inequality of the extremities be due to shortening or lengthening. Even with the tilting of the pelvis and the slight compensatory curvature of the spine there was noted a remarkable freedom from all symptoms and an absence of disability of every sort. Moderate degrees of shortening of the extremity, due to overriding of the fragments, in cases of fracture of the shaft of the femur in children is evidently of less significance than in corresponding injuries in adults, and the possibility of post-traumatic acceleration of growth of this bone in children should be kept in mind in passing judgment upon the efficiency of a particular method of treatment and particularly when some radical procedure is contemplated for the correction of overriding.

NOTE CONCERNING KERATIN AND KERATOHYALIN IN TUMORS OF THE HYPOPHYSIAL DUCT*

By PERCIVAL BAILEY, M.D

OF BOSTON, MASS

ASSOCIATE IN SURGERY, PETER BENT BRIGHAM HOSPITAL

IN a series of tumors of the pituitary region from the clinic of Dr Harvey Cushing which I have recently had opportunity to examine, there occurred three of the hypophyseal duct. In 1904 Erdheim,⁴ in discussing tumors of this region, postulated as a differential point that "cholesteatomata" contained keratohyalin and hypophyseal duct tumors did not. This statement has been contradicted among others by Bartels.² Recently Duffy,³ in examining some tumors of the hypophyseal duct, noted certain granules. He seems to have accepted the judgment of Bartels that they were keratohyalin and investigated them no further. Similarly Jackson⁵ in his cases seems to have accepted Erdheim's judgment and says that granules of keratohyalin are not found.

Absolutely fresh material removed at operation being available, it seemed worth while to investigate these granules as fully as possible. Incidentally reports of three cases may be added to the fifty-five collected by Duffy. For demonstrating the keratohyalin there was employed the modification of Pick's cresyl-violet method which I had previously used for keratohyalin in pearly tumors¹ (Perlgeschwulste, sometimes called cholesteatomata). Unna's alum hæmatoxylin method⁸ was also used. For keratin the gentian violet and safranin methods of Reinke⁶ were used, and also the Gram method proposed by Ernst with the Weigert modification. The sharpest pictures were obtained by staining heavily with Babes' anilin safranin and decolorizing with acid alcohol. The keratin-containing cells retain their bright red color after the rest of the section has been completely decolorized.

The clinical data concerning these cases will be given as briefly as possible, since we are concerned chiefly with certain histological details.

I *Benign squamous epithelial cyst*

This cyst may well have contained papillary or teratoid characteristics, but since only a small fragment was examined it must be placed here.

CASE I.—P B B H Surgical No 13453 *Cyst of hypophyseal duct origin*
Operation—evacuation Recovery

November 2, 1920 Admission of S N, age thirty-three, an engineer, with complaint of headache and blurring of vision. Referred by Dr A F Longeway, of Great Falls, Montana.

Present Illness—Began to have occasional frontal headaches in October, 1920. About the same time he noticed double vision and blurring. His libido

* From the Surgical Clinic of Dr Harvey Cushing, Peter Bent Brigham Hospital, and the Laboratory of Surgical Research, Harvard Medical School, Boston, Mass.

began to diminish Shortly afterwards there developed a mucopurulent discharge of the right nostril

Positive Findings—The patient had a soft, pale, dry and finely wrinkled skin Axillary and pubic hair were very scanty There was marked drowsiness and slightly subnormal temperature Bilateral optic atrophy and bitemporal hemianopsia were also present The basal metabolism was -16 The X-ray showed a saucer-shaped sella with slight erosion of the anterior clinoid processes

November 6, 1920 *Operation*—By the usual transsphenoidal procedure The floor of the sella was very thick and it was opened with difficulty Through it protruded a thin membrane, and when it was incised a milky, turbid fluid poured out of what was evidently a cyst The fluid contained a mass of beautiful cholesterol crystals

Microscopic Examination—A single very small fragment of the cyst wall was submitted for examination, which was fixed in Regaud's fluid

It was seen to consist of a short strip of stratified epithelium along one margin and for the rest of normal pars distalis of the character usually seen in the periphery of the gland Eosinophilic, basophilic and chromophobe cells were clearly distinguishable, the latter predominating

The epithelium, evidently the wall of the cyst, consisted of two or three layers of irregularly cuboidal cells with lightly staining, almost homogeneous cytoplasm The cells of the inner layer were larger, more regular and more lightly staining Nearly all the cells were extensively vacuolated The nuclei were vesicular and also stained very lightly In the cytoplasm of these cells were seen often discrete granules of keratohyalin of varying size The cells of the basal layer of epithelium contained rarely a few fine granular mitochondria

II *Adamantinomatous tumors*—These cases are called by Roussy and Cluett "Neoplasiques ou tumeurs heterotopiques, epitheliomata pavimentaux"

CASE II—P B B H Surgical No 14011 *Tumor of the hypophysial duct, cystic Operation—partial extirpation Fatality Autopsy*

February 15, 1921 Admission of H S, age eleven, a schoolboy, with complaint of loss of vision and frontal headache with vomiting Referred by Dr A Heard, of Austin, Texas

Present Illness—Since six years of age the patient's eyes had troubled him In 1916 vision in the right eye began to fail rapidly and was lost entirely in June, 1919 Headaches had been severe since 1919 and frontal in location They were occasionally accompanied by projectile vomiting Since 1919 vision had been failing in the left eye Sometimes he had a ravenous appetite He had been wearing the same clothes for two years and during this time had gained fifteen pounds in weight, but had not increased in height

Positive Findings—There was found total blindness in the right eye and a temporal defect in the left visual field Primary optic atrophy was present in both eyes, more marked in the right He was under height and overweight for his age His skin was dry, sallow and finely wrinkled The genitalia were very small The X-ray showed separation of the suture lines, considerable generalized convolutional atrophy of the inner table of the skull, and marked changes in the sella turcica The floor of the enlarged sella was depressed into the sphenoid sinus and the dorsum sellæ was very thin

February 18, 1921 *Operation*—This was a somewhat difficult transsphenoidal procedure owing to the boy's small nose The sphenoidal cells also were poorly developed and there was a thick median septum It was therefore difficult to clear the sella, which was quite large The exposure was very small and on

TUMORS OF THE HYPOPHYSIAL DUCT

incising the dura a solid tumor was found. A fragment was taken and examined immediately. On finding an epithelial tumor a considerable portion of the sellar contents was removed. Suddenly there was a gush of cloudy, milk-white fluid, evidently from a cyst, and the whole area collapsed and began pulsating. It seemed perfectly dry and was closed.

Post-operative Course—The patient soon developed a cerebrospinal fluid leak and succumbed to meningitis.

February 28, 1921 *Autopsy* (Dr C E Locke)—A tumor was found in the region of the pituitary. "It was apparently solid and about 2 cm in diameter. The tumor seemed to encircle the chiasm." Some fibrinopurulent exudate around the base contained numerous staphylococci.

Microscopic Examination—The material was fixed in 10 per cent neutral formalin, Zenker and Regaud's fluid. Along one side of the section were found a few columns of normal pituitary cells, mainly chromophobe. The rest of the material consisted of a typical squamous, epithelial, adamantinomatous tumor.

The tumor was composed of almost a solid mass of squamous epithelial cells with typical intercellular bridges. Scattered around were numerous areas of cystic degeneration, with here and there a blood-vessel. There was but very little connective tissue around the blood-vessels only.

The cytoplasm of the cells was very scanty and around each nucleus was a row of very fine granular mitochondria. Occasionally areas of keratinized cells were found and, around these cells, with granules of keratohyalin.

CASE III—P B B H Surgical No 13832 *Suprasellar Tumor of Hypophysial Duct, cystic. Unusual case with Choked Discs. Subtemporal Decompression. Subsequent Transfrontal Operation. Extirpation. Recovery.*

January 7, 1921 Admission of F D, a dentist, age thirty-four, with complaint of blindness in the right eye and headache. Referred by Dr Alex Quackenbos, of Boston, Mass.

Past History—Luetic infection in 1908, badly treated for the first three months, but later thoroughly treated for three years.

Present Illness—Began in June, 1919, with sharp stabbing pains in right supraorbital region when coughing or sneezing. In March, 1920, he noticed some blurring of vision in the right eye. In June, 1920, he was found to have a temporal defect in the right visual field. In October, 1920, spinal puncture revealed a positive globulin test and thirty-four cells per cubic millimetre. The Wassermann was negative. Headaches continued and began to be associated with vomiting in November.

Positive Findings—There were found bilateral choked disc of 2-2½ D and a bitemporal hemianopsia. The visual acuity in the right eye was 5/200 and in the left 20/20. Tendon reflexes brisk to exaggeration. The X-ray showed some evidence of bone destruction with bone activity in the region of the sella turcica, the dorsum sellæ itself participating in this change. There seemed to be some calcification just above the sella turcica associated with the destruction process in the dorsum.

January 5, 1921 *Operation*—This was the usual subtemporal procedure. A somewhat wet and elastic brain bulged on incising the dura—a typical hydrocephalic brain. A puncture was first made in the superior temporal convolution with negative findings, and a second puncture through the lower convolution obliquely backward, striking the ventricle. A large amount of fluid was secured, greatly lowering tension. Examination of the fluid showed three cells per cubic millimetre.

January 25, 1921 *Discharged*—Decompressed area was tense. Discs were elevated about 1½ D. No improvement had occurred in visual fields. The patient was told to return in a few weeks.

February 1, 1921 *Second Admission*—His headaches had recurred and no improvement had occurred in vision

February 7, 1921 *Second Operation*—This was a transfrontal procedure. The boneflap was reflected from the right frontal region, exposing the tense dura. A needle was inserted into the ventricle and 60 c c of fluid escaped. It was then possible to elevate the frontal lobe from the level of the orbit without difficulty. On incising the dura at the margin of the sphenoidal crest there began to extrude from the incision as it was enlarged the bulging wall of the cyst, and before the incision could be enlarged as much as was finally necessary, the cyst ruptured and a purulent-looking, watery fluid, containing an abundance of cholesterol crystals, began to extrude itself. The cyst must have been a very large one, for about 40 c c of this material was finally secured and an equal amount must have been lost. Between the right olfactory nerve and the chiasm was a solid portion of tumor largely made up of calcareous fragments which widely separated the legs of the chiasm and extended deeply into the pituitary fossa. This mass was finally dislodged and tilted out of its bed. The pituitary scoop, which made it possible to detect the rough inner surface of the cyst owing to the lime deposit upon it, was used, and what seemed to be the larger part of the cyst was removed. By pulling upon the fragments of cyst wall a large portion of it was dislodged and drawn down toward the region of the third ventricle, though by no means all of it, for it was feared damage might be done.

February 28, 1921 *Discharged*—Fundi showed no measurable swelling. Headaches were entirely relieved. Visual fields filled out almost to normal limits and visual acuity to 20/20 in the left eye and 20/40 in right.

Microscopic Examination—The tumor found at operation was a typical cystic epithelial adamantinomatous tumor of the hypophysial duct. It was composed of a mass of squamous epithelial cells with typical intercellular bridges. There were numerous areas of cystic degeneration and numerous areas of keratinized cells. Many cells contained keratohyalin granules. Around the nuclei of the epithelial cells were a few fine granular mitochondria. The keratinized cells, however, contained none. The keratohyalin granules took the acid fuchsin sharply.

COMMENT

In all three of these tumors were cells containing granules which stained heavily by the methods ordinarily used to demonstrate keratohyalin in the skin. They are in all probability of the same nature. In two of the tumors cells were also found which stained heavily by methods used to demonstrate keratin in the skin and hair.

It should be noted that the fluid from two of the cysts reported here contained cholesterol crystals. In the other case they seem not to have been looked for. They will be found in many cysts of the hypophysial duct as Erdheim admits. In Erdheim's masterly paper it seems to me that among his so-called cholesteatomata the Cases XIII and XV are similar to Case I of this report. Both are said to have contained hair. It has been pointed out elsewhere that the term "cholesteatomata" is an unfortunate one and allows such cysts of the hypophysial duct which contain cholesterol crystals, as well as other growths, such as the so-called cholesteatomata of the middle ear, to be confused with the "tumeurs perlées" of Cruveilhier.

TUMORS OF THE HYPOPHYSIAL DUCT

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TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting Held April 27, 1921

The President, DR WILLIAM A DOWNES, in the Chair

TENDON TRANSPLANT FOR WRIST-DROP

DR. JAMES N WORCESTER presented a man, thirty-six years of age, who had received a compound fracture of the right humerus in September, 1908. Non-union resulting he was operated on and a silver wire inserted. Immediately following the injury musculospiral paralysis was present. An attempt was made in March, 1909, to repair the nerve but without result.

DR. ALFRED TAYLOR exposed the nerve, a four-inch defect of which was found. A nerve transplant was done and also a silk suture was inserted between the biceps muscle and the radius. There has been no return in nerve function after a period of nine years since last operation. The condition is now, March 1, 1921, one of complete paralysis of the extensor muscles of the wrist, there is no extension of fingers. Motions of elbow normal. Power of flexion very much lessened due to separation of the biceps and the brachialis anticus muscles from their insertions.

Operation At the Reconstruction Hospital, March 9, 1921. Procedure: Incision over insertion of flexor carpi radialis, tendon cut and freed by blunt dissection upwards for a distance of three inches, similar incision and procedure over insertion of flexor carpi ulnaris. These two loosened tendons were brought out through a small opening in the skin three inches above points of insertion. Median incision then made over dorsum of wrist and extensor tendons exposed. Tendon of extensor brevis pollicis, extensor longus pollicis and extensor indicis split and tendon of flexor carpi radialis passed under skin and through the split and sutured with fine silk. Extensor tendons of third, fourth, and fifth fingers split in similar fashion and tendon of flexor carpi ulnaris brought under skin and through these and sutured with fine silk. Fascia closed over line of suture with fine plain gut and skin closed with silk.

Post-operative Course Following operation, patient developed pneumonia and was very ill for a few days. Motions of the wrist were begun immediately post-operation and active motions particularly encouraged. The wrist-drop disappeared after operation and power of extension has gradually increased to present state. At present he has almost complete extension of the fingers, the thumb and index-finger working together. The wrist-drop has disappeared, although the power of extension was not normal but was improving.

FLAP TRANSPLANT FOR BURN OF HAND

FLAP TRANSPLANT FOR DEFECT OF SOLE OF FOOT

DR. JAMES N WORCESTER presented a man, twenty-five years of age, who in France received a bullet wound of the plantar surface of the right foot. He was admitted to the Reconstruction Hospital, August 14, 1919.

On the plantar surface of the right foot over the metatarsophalangeal joint was an area of very dense scar tissue extending entirely across the sole of the foot and about two inches in length. This scar tissue was adherent to bones and tendons, there was no motion present in the toes. In the centre of the scar tissue was a deep ulcerated area three-fourths inch in diameter, which was extremely painful. Under rest in bed this healed but immediately broke down again when pressure was put on it.

Operation, July 26, 1920 Procedure Scar tissue dissected away from bone and tendon. A flap was then turned down from the calf of the left leg in shape to correspond to the defect of right sole which was sutured to edges of defect with interrupted silk sutures and plaster cast applied. The pedicle was cut at the end of ten days. The patient was kept in bed for six weeks and at the end of eight weeks he began to walk, using a pad made of rubber bath sponge directly over graft, which has remained entirely healed. Patient walks without pain and is working.

FLAP TRANSPLANT FOR BURN OF HAND

DOCTOR WORCESTER also presented a man, aged thirty-eight years, who received a burn involving the whole of the left hand on March 24, 1919, in a gasoline explosion. He was admitted to the Reconstruction Hospital September 19, 1919. The whole dorsum of the left hand was involved in dense scar tissue extending from the wrist to the finger tips; the second, third and fourth fingers are rigidly fixed in extension, the little finger shows a partial dorsal dislocation of first phalanx due to contracture. Thumb is dislocated posteriorly, standing out from hand at right angles. There is complete loss of flexion of all the fingers. The scar tissue shows numerous cracks and ulcerations and the circulation is extremely poor. Patient was treated with physiotherapy, using particularly whirl-pool baths, massage and baking. The circulation improved and there was a gradual increase in the movements of the fingers.

Operation January 6, 1920 Scar tissue over dorsum of thumb was excised down to tendons and it was then possible to reduce the dislocation. The defect was covered by means of a flap from the abdomen. The pedicle was cut at the end of ten days and circulation of flap remained good.

Second operation, April 6, 1920 Amputation of little finger.

Under continued physiotherapy motions in fingers and thumb have increased until at present he has an extremely useful hand.

When patient was admitted to hospital, amputation of hand had been advised.

CANCER OF THE LARGE INTESTINE NOT INCLUDING RECTUM
OR RECTO-SIGMOID

DR JAMES I RUSSELL read a paper with the above title, for which see p 755, June ANNALS OF SURGERY, vol lxxiii

DR JOHN ERDMAN said that in his personal work 1916 to 1920 he had sixty-four cases of large intestinal growths, of which twenty-five were growths of the recto-sigmoid, and the remainder were of the cæcum, ascending colon, transverse colon, splenic flexure, etc During the same period he had done thirty-nine additional operations of the same kind on private patients elsewhere, making a total of 110 growths of the large intestine Of these 110 growths, thirty-nine were of the recto-sigmoid, sixty-one of the cæcum, ascending colon, etc , two were cases of tuberculosis of the cæcum There were twelve cases involving the hepatic flexure and the right three-quarters of the transverse colon and four involving the left one-quarter of the transverse colon and the splenic flexure There were twenty-seven sigmoidostomies A mortality operation of 15 per cent The general mortality for the entire series, including emergency operations, was 24 per cent This mortality includes non-operative also

It had been his custom to do the two-stage operation He did a cæcostomy in the majority of the cases instead of a sigmoidostomy or a transverse colostomy It was true that in doing a sigmoidostomy the operative work was a little more difficult That with a cæcostomy, although more difficult to clean the entire colon, one could readily with care and attention accomplish the act At the end of ten or fifteen days he did the resection

He had recently done one lateral anastomosis of the transverse colon and the patient was in the hospital at the present time and making a good recovery In patients in whom there were metastases in the liver he had not hesitated to do radical work, because patients with metastases in the liver were bound to live twelve to twenty-four months, and if the growth was excised they were much more comfortable, and if an anastomosis could be made it prevented the discomfort of an artificial anus He had followed this procedure which had been very satisfactory and had afforded a great deal of comfort in many instances

Two cases of special interest in this connection were the following Thirteen years ago he removed a transverse colon in a young man of thirty-four The pathologist reported that the growth was a colloid carcinoma He recovered from the operation, lived eleven years, and died of sarcoma of the right shoulder The roentgenologist was absolutely certain that the growth in the shoulder was not a carcinoma Five weeks ago he had operated on this man's sister, who was thirty-one years of age at the time, for a growth in the sigmoid The pathologist reported that the growth was an adeno-carcinoma with colloid degeneration

CANCER OF THE LARGE INTESTINE

DR CHARLES N DOWD stated that the diagnosis of these cases had puzzled surgeons for many years but that some progress had been made and the average time of diagnosis is much earlier than it used to be

One of the most important elements in this kind of surgery is the determining of the amount of intestine which should be resected This question depended largely on the path of lymphatic drainage and the consequent spread of infection

Jamieson and Dobson did some very valuable work on this subject several years ago They demonstrated that the lymphatics at the centre of an arterial arcade must travel a considerable distance parallel with the intestine before reaching the main arterial trunk, therefore, in many instances, the excision of a large section of the colon is desirable The ascending colon, the lower end of the ileum and the hepatic flexure should be removed in one section to secure immunity from infection which follows the course of the ileo-colic vessels

In the transverse colon the lymphatic current easily reaches the region of the median colic artery Hence only a moderate resection is needed in this region In the region of the splenic flexure the resection should include about one-half of the transverse colon and a large part of the descending colon

In the region of the sigmoid colon the theoretical resection should extend from the lower descending colon to the middle portion of the rectum, but this is usually inadvisable since the mechanical difficulties are so great. Moreover, there is only a slight lymphatic supply to this region and the local excision of growths there has been attended with a considerable measure of success Hence a resection extending from the upper end of the sigmoid to the lower end of the sigmoid is advised

In doing this work one must always be guided by the patient's condition and the degree of resection must be adjusted to that However, the colon is easily mobilized by cutting the outer leaf of its peritoneum and there is probably more error in attempting too little resection than in attempting too much

Again there is sometimes a difficulty in making a diagnosis between diverticulitis and carcinoma even on the operating table and, of course, complications arise from that cause A very moderate resection in diverticulitis is sufficient

As to the method of operation Doctor Dowd said that he did not advocate the Mikulicz operation for the ascending colon but in the transverse colon, the descending colon and in the sigmoid this operation gave so much safety that most patients were willing to accept a moderate delay in healing for the sake of securing this safety

DR WILLY MEYER called attention to a method of cæcostomy which he had devised and considered very simple and satisfactory He first made McBurney's intermuscular incision and removed the appendix, then he sutured the appendix into the peritoneal wound In emergencies it was opened immediately, otherwise after twenty-four hours For that purpose he penetrated

the gut with the tip of a straight Paquelin cautery. With the discharge of the eschar the hole enlarged so that in a few days one could easily introduce one's forefinger and palpate. One could then pass a soft rubber tube to the transverse colon for the purpose of irrigation. If there was a stricture the fluid would regurgitate and come back through the wound. Doctor Meyer asked the members, if called upon to do a cæcostomy, to give this method a trial. If one got these cases in the advanced stage when they were vomiting one could employ this procedure easily under local anæsthesia and still hold to the two-stage operation. Later, after the radical excision of the tumor, the cæcal opening closed spontaneously.

In cases of less marked obstruction Doctor Meyer favored the two-stage operation, beginning with a lateral anastomosis. This obviated the necessity of establishing a temporary artificial anus. In a patient who had been under the care of others for cholecystitis for several years, Doctor Meyer said he found a large tumor of the ascending and transverse colon. These colonic tumors sometimes grew very slowly. In this case he first did an ileocolostomy, in the second stage he resected the tumor and inverted either end of the gut. In the specimen there was found a pretty tight constriction. The lumen was just large enough to pass a pencil, yet the patient had bowel movements. After several years she developed hæmaturia and in examining her cystoscopically, a sessile tumor of the bladder was found. This was promptly excised, the bladder closed with ureteral drainage. She recovered again and was alive to-day without recurrence, sixteen years after operation.

DR W S SCHLEY said that in connection with the question of technic it was an advantage to use the intermuscular incision. For the right side it was almost indispensable in cæcostomy both for a permanent or temporary opening. For the Mikulicz operation it was extremely easy and practical and greatly facilitated subsequent closure. He had used it for fifteen to eighteen years and had found it practical in every way. The abdominal muscles acted well as a cut-off, particularly on the left side.

DOCTOR AUCHINCLOSS stated that in doing an anastomosis in cases not acute he made use of an ileocolostomy as had been done by others. The gut was not opened except when clamped. He used Kocher clamps. The clamp was put on the side of the large gut its mouse-tooth point brought up to the surface. The whole of the included two walls of the gut was then burned off. The small gut was then clamped straight across and burned through so that there were two cauterized clamped holes to be sutured. This was done on one side of the clamps and then with the clamps rotated over the suture was continued around the gut. Just before the suture ends were tied the clamps were slipped off and the anastomosis completed by tying the ends of the two suture lines to their respective starting points.

The colon anastomosis case shown at the last meeting done by the above method was an end-to-end anastomosis in the rectum and the case did not leak nor have a stricture. He was just beginning some attempts to carry

CANCER OF THE LARGE INTESTINE

out this method on dogs, but the first attempt in a dog was unsuccessful because the clamps used were entirely too large for the purpose. It was his hope to continue, however, and to study the sections of repair following such anastomoses from the standpoint of hemorrhage and stricture

DR WM. A. DOWNES spoke of anastomosing around the growth to prevent the formation of an external fistula and said he had had several very good results. One woman with carcinoma of the transverse colon had gone along for four years after an anastomosis around the growth and then died of intercurrent disease. This procedure was a very good thing to bear in mind

As to the bismuth meal, in cases of suspected growths in the intestine bismuth enema was always given first, and if there was evidence of obstruction

With reference to diverticulitis, Doctor Downes cited a case who had been treated palliatively for four months. He then had a sudden chill and a large quantity of pus was discharged from the bladder. This continued four or five days. At operation it was found that an abscess had formed and had ruptured into the bladder. The opening into the bladder was closed and a rubber dam placed between the bladder and the sigmoid, and though there was a fecal fistula for seven or eight months the man recovered

DOCTOR ERDMAN said that where there was no obstruction it was not necessary to do a cæcostomy, nevertheless he felt that a preliminary cæcostomy or colostomy was necessary because in that way the toxins were washed out. The statement that it was sepsis that kills answers the question as to the necessity for a preliminary colostomy or cæcostomy

DOCTOR RUSSELL agreed with Doctor Dowd in the value of the two-stage Mikulicz operation, particularly in the left half of the colon, but preferred the one-stage primary resection in the right side and transverse colon. It is true that the two-stage operation kept the patient in the hospital a little longer, but it was much safer. It was well known that it was sepsis that killed these patients.

There was an operation described about twelve years ago which he had done once or twice but had never done it in the large intestine. In this operation the lumen was burned across close to a narrow crushing clamp, the clamps approximated and a suture done over them, the suture being tied at the convex border of the intestine as the clamps were withdrawn. The lumen was then established by rubbing the charred ends together through the continuity of the wall of the intestine. In this way the intestine is not opened at any stage during active operative procedure. In opening the intestine one was almost sure to get some contamination and, as is well known, is highly infectious in the large intestine. The patients did well for about forty-eight hours, then became sick and many died. To avoid such occurrence it is better to do a two-stage Mikulicz operation, for it is not a question of twenty-three or seventy-two days in the hospital but one of getting the patient well and avoiding sepsis

CORRESPONDENCE

RUPTURE OF UTERUS

EDITOR *ANNALS OF SURGERY*

SIR In the Transactions of the Philadelphia Academy of Surgery, published in the August number of the *ANNALS OF SURGERY* at p 251, the mistake has been made of attributing to me case reports of "Rupture of Uterus During Attempts at Version," "Double Amputation of the Thigh for Senile Gangrene" Both these case reports were made by Dr Irvine M Boykin

Very truly yours,

ASTLEY P C ASHHURST

To Contributors and Subscribers

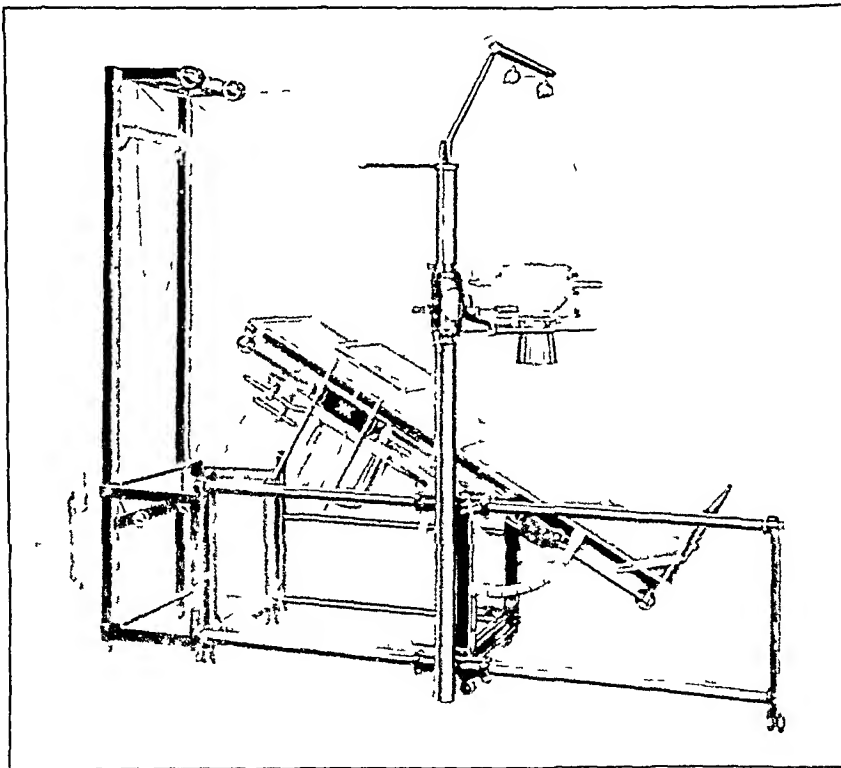
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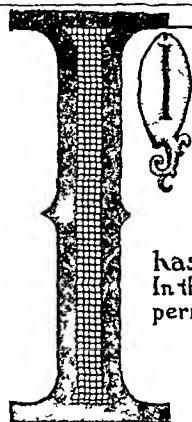
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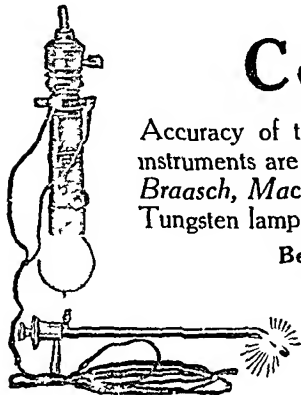
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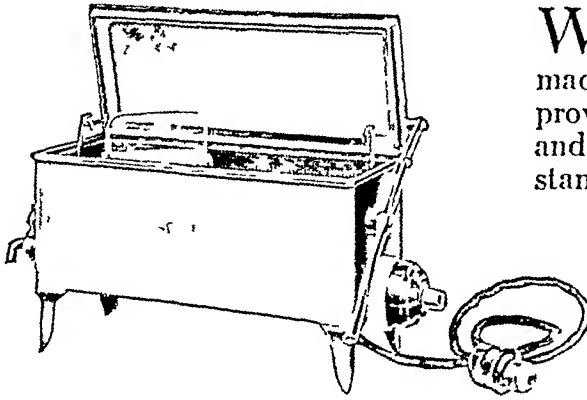
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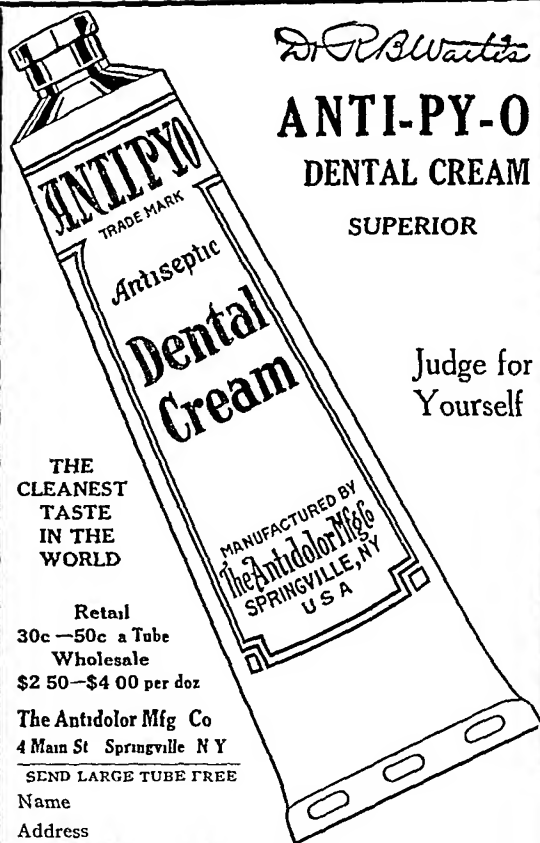
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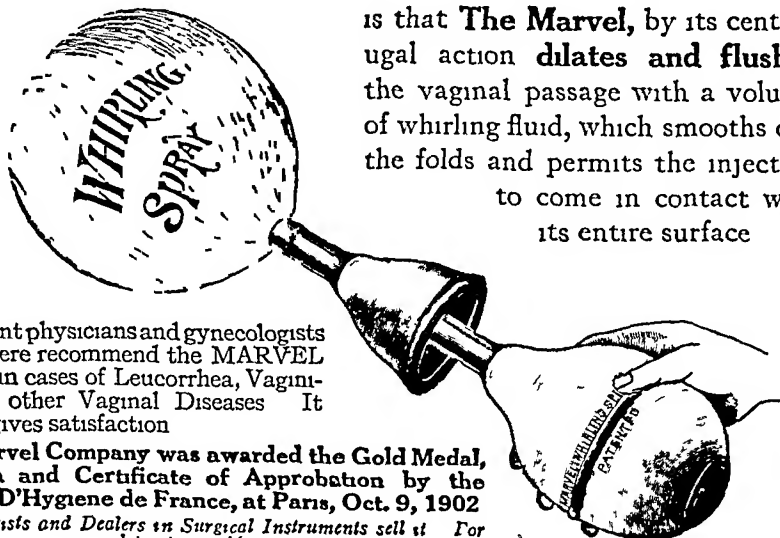


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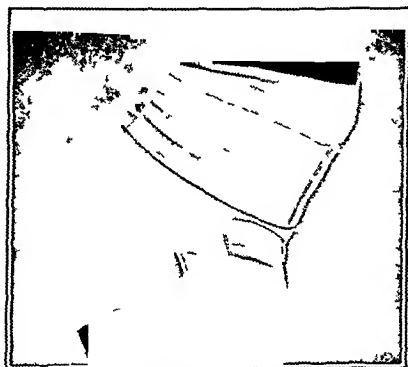
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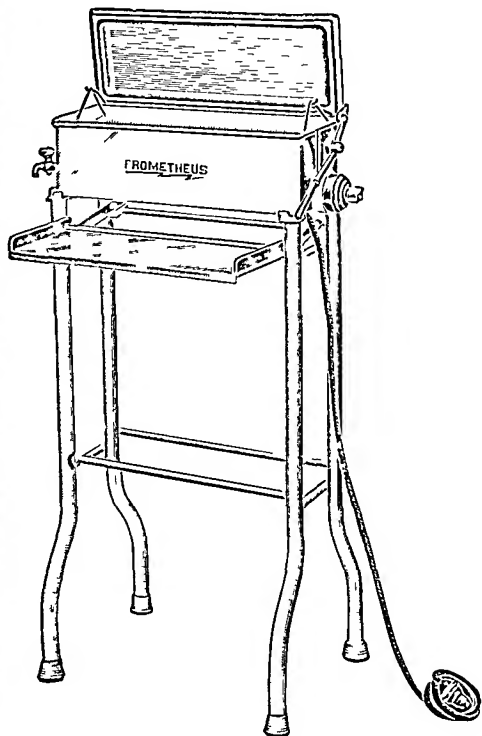
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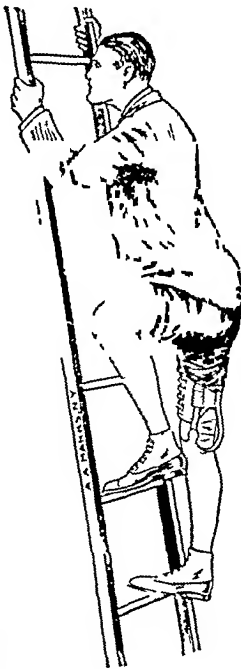
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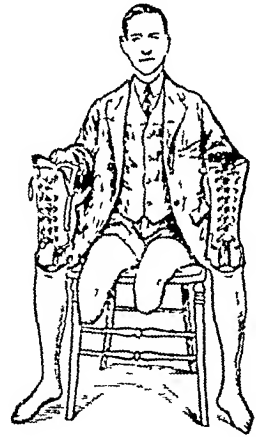
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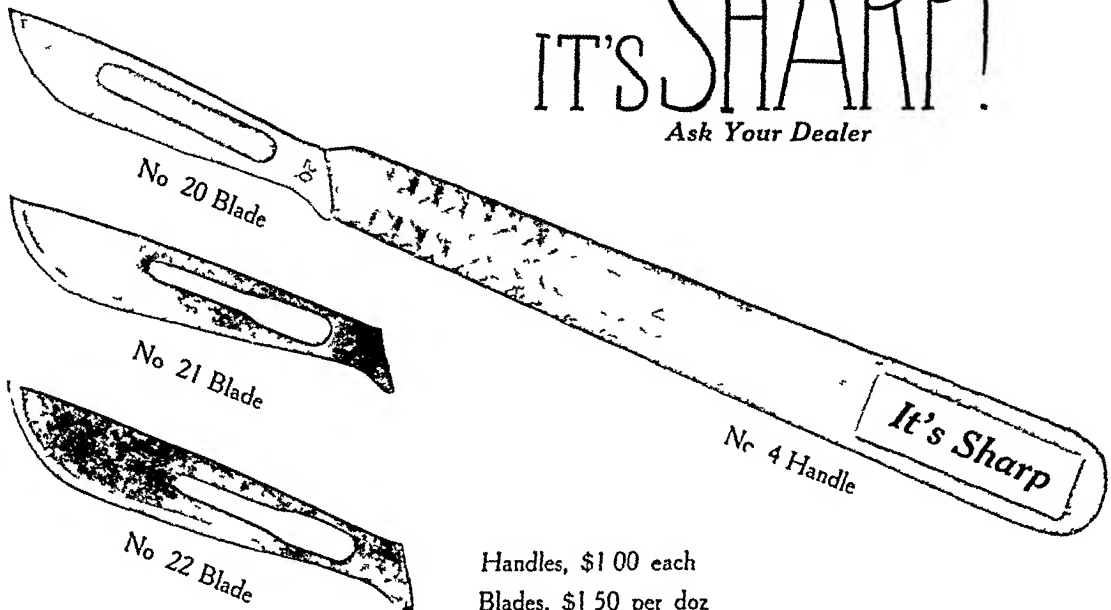
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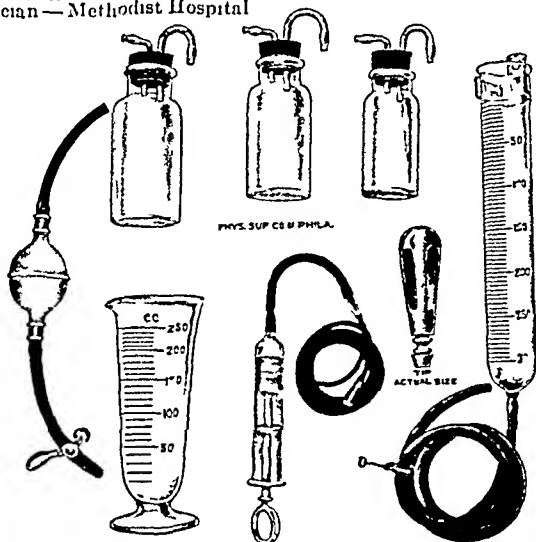
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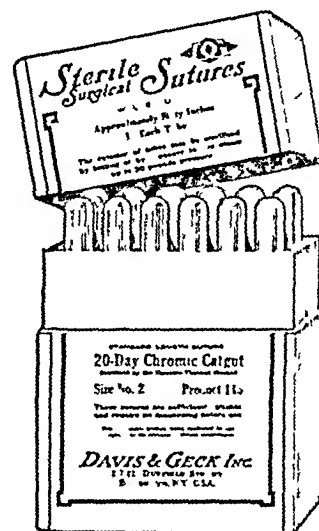
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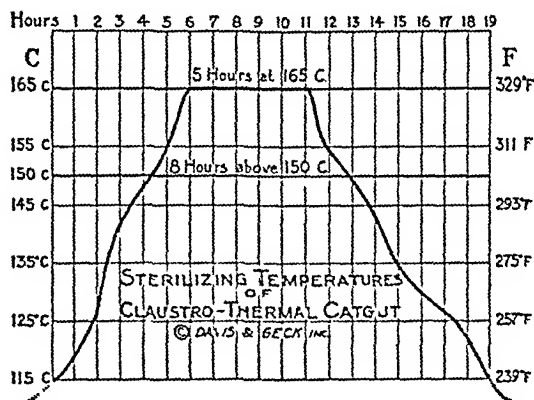
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0	_____
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Product No		Approximate Quantity in Each Tube	Standardized Sizes
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360	Horsehair	Four 28-Inch Sutures	00
390	Plain Silk worm Gut	Four 14-Inch Sutures	00, 0, 1
400	Black Silk worm Gut	Four 14-Inch Sutures	00, 0, 1
450	White Twisted Silk	60 Inches	000, 00, 0, 1, 2, 3
460	Black Twisted Silk	60 Inches	000, 0, 2
480	White Braided Silk	60 Inches	00, 0, 2, 4
490	Black Braided Silk	60 Inches	00, 1, 4
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Short Length - Without Needles

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Product No		Approximate Quantity in Each Tube	Standardized Sizes
802	Plain Catgut	20 Inches	00, 0, 1, 2, 3
812	10-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
822	20-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
862	Horsehair	Two 28-Inch Sutures	00
872	Plain Silk worm Gut	Two 14-Inch Sutures	0
882	White Twisted Silk	20 Inches	000, 0, 2
892	Umbilical Tape	Two 12-Inch Ligatures	

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With Needles

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914	10-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
924	20-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
964	Horsehair	Two 28-Inch Sutures	00
974	Plain Silk worm Gut	Two 14-Inch Sutures	0
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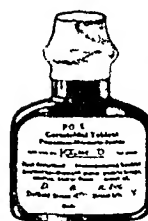
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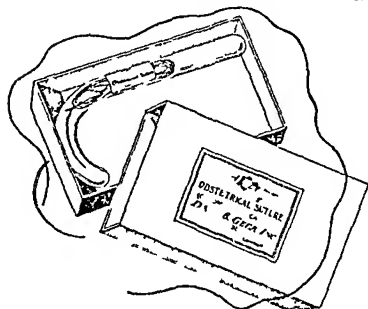
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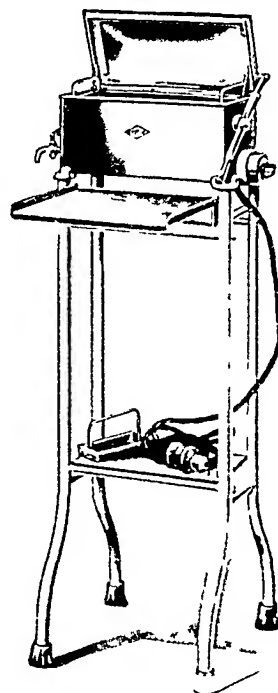
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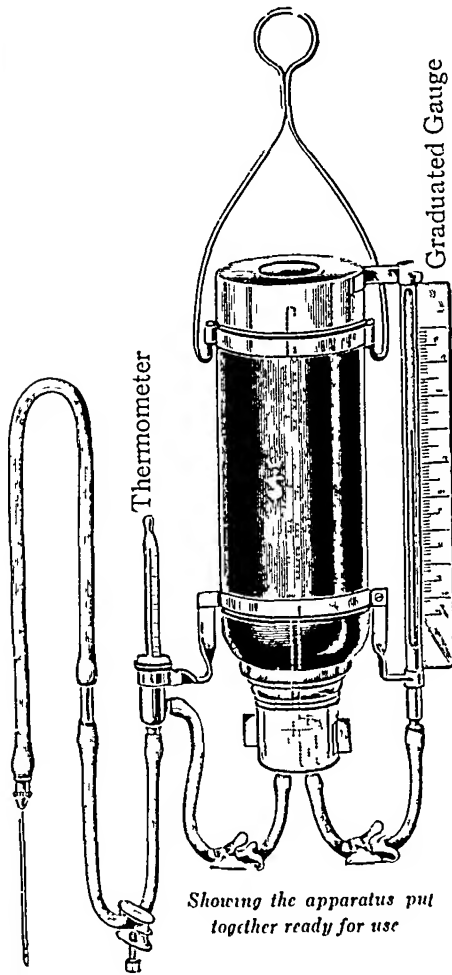


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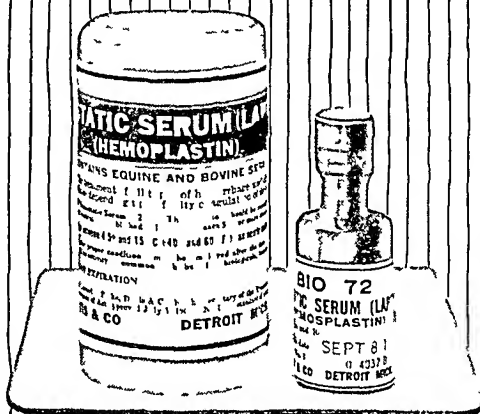
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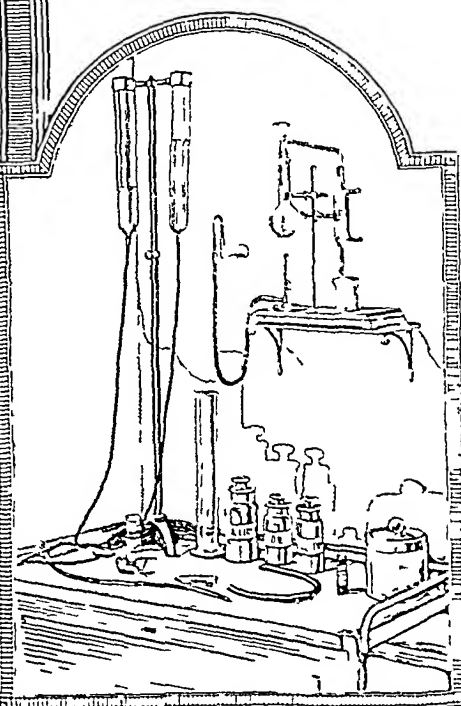
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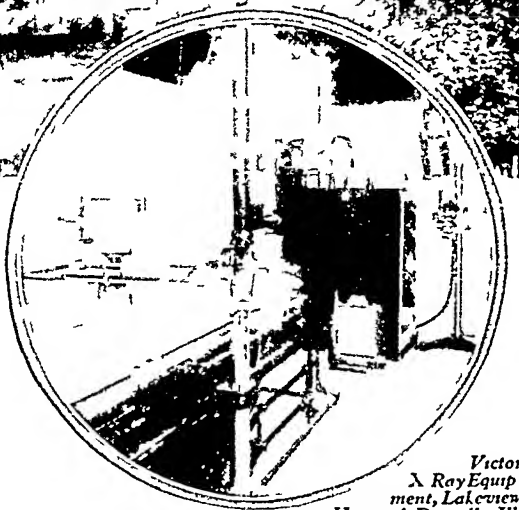
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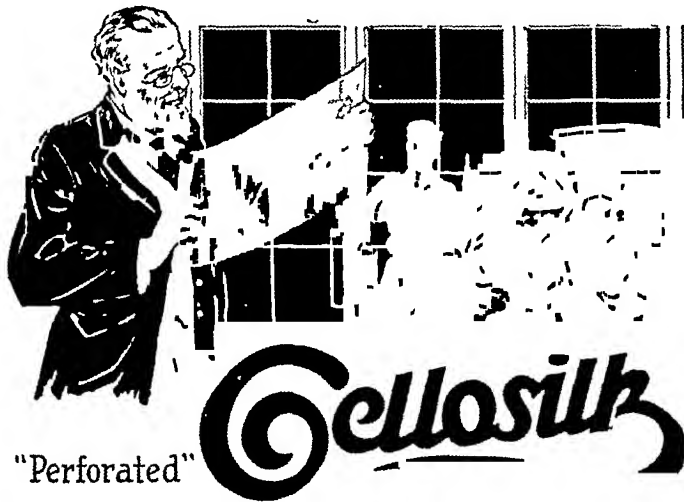
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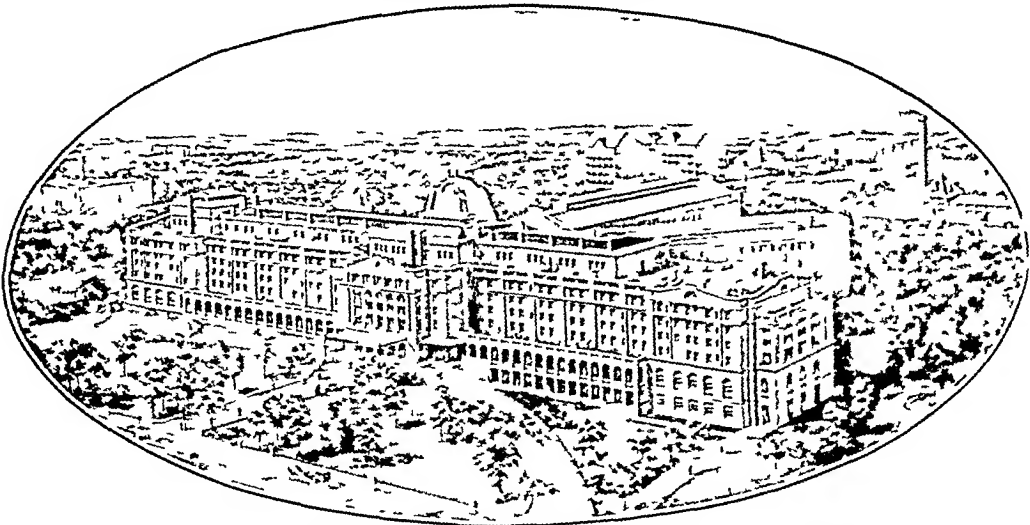
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RESULTS OF TWENTY-ONE CASES OF SURGICAL TREATMENT OF ANEURISM

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SECTION ON SURGERY, THE MAYO CLINIC

TWENTY-ONE patients with aneurisms, exclusive of thoracic and cirroid aneurisms, were operated on at the Mayo Clinic, by various members of the staff, between January 1, 1907 and November 1, 1918. The type of aneurism, its location, the operation, and the results obtained are listed in the tabulation.

A complete cure was effected by operation in thirteen cases. In three of these, in which the aneurism involved relatively unimportant vessels, the operation consisted of proximal and distal ligation with excision of the sac. Four were proximal ligations only, three of the external carotid artery and one of the internal iliac artery. In one case a ligature was tied around the base of the sac. In three cases a Matas reconstruction endo-aneurismorrhaphy was done, two for aneurism involving the popliteal artery, and one for aneurism involving the femoral artery in Hunter's canal. In one case a compression suture was thrown around the communication in an arteriovenous aneurism. In one case the opening in the artery was sutured by opening the sac.

Improvement in one case was obtained by the Matas obliteration operation in a popliteal aneurism, in another by proximal ligation for an aneurism of the common carotid, and in another by a Neff clamp placed on the common iliac proximally to an aneurism on this vessel. One patient apparently was well for three years after proximal ligation of the subclavian artery for a subclavian aneurism and then he had a sudden recurrence. One patient was not improved by the proximal ligation for aneurism of the posterior tibial artery. There were three deaths in the series. One (Case V) occurred during an attempt to excise a subclavian aneurism which had been ligated two months before and had not been relieved by a proximal ligation. Death resulted from a cerebral embolus loosened by manipulation of the sac, as was shown at necropsy. One death (Case XII) was the result of cerebral changes following ligation of the common carotid artery and internal jugular vein, twenty-eight days after the application of a lead compression clamp to the internal carotid in a patient aged sixty-six, with an arteriovenous aneurism between the common carotid artery and cavernous sinus. The third

death (Case XX) was probably due to circulatory disturbance, it followed the application of a Neff clamp proximal to an aneurism of the common iliac artery

Residual disability due to circulatory disturbances in the extremity following the Matas operation on the popliteal artery persisted in one case. In this case there were some numbness and formication in the foot, but function was good and the trouble had practically cleared up eight months after operation.

The type of operation indicated and the time of surgical interference in each case depends largely on the location and type of aneurism to be dealt with, and especially on the efficiency of the collateral circulation. The latter factor may be estimated clinically, as pointed out by Matas¹. In injuries to the large blood-vessels with threatened gangrene, Tuffier² has used arterial intubation with silver tubes and believes that in some cases gangrene may be prevented by allowing time for the establishment of collateral circulation before ligation of the injured vessel. Makins³ states that aneurismal varices and arterial hæmatoma do not usually require early surgical treatment and in many cases are better if untreated. Surgical interference, however, is indicated if there is spreading infection of surrounding tissue, extension of blood effusion or external secondary hemorrhages, threatened gangrene of the limbs, or acute infection of the hæmatoma itself. Surgeons in the recent war found circular and lateral suture rarely practicable for obvious reasons, but successes are reported by Goodman⁴, Haberer⁵, and others. Proximal ligation, proximal and distal ligation, with or without excision of the sac, and in cases of arteriovenous aneurism, quadruple ligation, constitute by far the most common procedures reported for vascular injuries during the recent war.

In old traumatic and arteriovenous aneurisms, good results are obtained by proximal and distal ligation with excision of the sac, provided the vessels involved are small and their ligation will not cause disturbance of circulation to the periphery. In aneurisms of the large arteries, particularly of the femoral, popliteal, and posterior tibial, this method is extremely dangerous, for circulatory disturbances in the limb very frequently result even in young adults, as has been pointed out by Makins³. In such cases in which the collateral circulation is inefficient or doubtful, some operation that will leave the lumen of the vessel intact or interfere with the collateral circulation as little as possible, must be chosen. Ligation of the base of the sac, as performed by C. H. Mayo in Case XIII, is feasible for some cases. Passing an unabsorbable ligature about the point of anastomosis in arteriovenous aneurism may be done successfully, as illustrated by Case XVIII. The most practicable method, however, and the one that is the most often applicable, especially in the lower extremity where a constrictor can be applied proximal to the lesion, is some form of the Matas operation. Halsted⁶ prefers partial occlusion or extirpation when constriction cannot be applied, as in case of aneurisms of the iliac and subclavian vessels.

In the series herein reported satisfactory results were obtained in the four

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cases in which the Matas operation was performed. The most successful operations in this series were proximal and distal ligations with excision of the sac when the aneurisms did not involve an important artery, and the Matas operation when a large trunk was involved. The results of proximal ligation were uncertain.

The results in these cases, although too few to be of great value in drawing conclusions, seem to indicate that double ligation and excision of the sac is the method of choice in cases of aneurism of the small arteries, since shutting off their blood supply is not followed by untoward results. The method of gradual occlusion with clamps gave only indifferent or poor results in the cases in which it was tried.

REPORT OF CASES GROUPED ACCORDING TO TYPE OF OPERATION

PROXIMAL AND DISTAL LIGATION WITH EXCISION OF THE SAC (THREE CASES)

Case I (76029) Mrs J E S, aged twenty-six, who was examined November 13, 1912, had been curetted seven months previously, three days after the birth of a child, because she had chills and fever. The fever subsided for five days and then returned. A second curettement was done and the patient became delirious with fever. This subsided, and a painful swelling appeared in the lower left side. Two other curettements were done with continuance of pain and chills. A surgeon was called who operated and found aneurism (?) of the uterine or internal iliac artery. The hæmatoma and the wound were drained and the patient recovered quickly.

At the time of examination at the Clinic the uterus was found to be slightly enlarged, with a soft swelling to the left. Pulsation and soft thrill were detected in the mass. The veins were not enlarged, the femoral pulse was equal. The mass extended below and seemed to be next to the vaginal wall on the left. A to and-fro murmur with systolic accentuation was best heard over the left iliac fossa.

At operation November 16, 1912, an aneurism about 7 cm. long was found which extended downward from underneath the external iliac vein into the base of the left broad ligament, anterior to and beneath the ureter, so that it felt, through the vagina, like an aneurism of the uterine artery. By compression over the iliac veins it was found that pulsation could be stopped. A ligature was placed underneath the external iliac vein one-half inch from the external iliac artery, and the second ligature was applied 1.25 cm. to the inner side, but not completely distal to the aneurism. The proximal ligature was well approximated to the aneurism. The cavity was opened by cutting half way across its lumen, it was closed by catgut sutures. Large branches of uterine and vaginal arteries were cut and tied. The round ligaments were cut and the broad ligaments were opened from the top. The ureter was separated from the mass. The left ovary and tube showed signs of old inflammation. The tube was opened but it was not considered necessary to remove it. Catgut ligatures were applied. The broad ligaments were closed, and the appendix was removed. In this case a rather frequent anomaly was present, the obturator artery had its origin in the deep epigastrium, and passed behind the external iliac vein, with the deep epigastric, to a very short common stump. The aneurism may have been traumatic.

The patient had an uncomplicated convalescence. A slight numbness persisted in the left leg for a time, but gradually disappeared.

Case II (105740) Mrs B A J, aged thirty-nine, had had a dull aching pain in the right shoulder and down the arms following an attack of grippe six years previous to examination at the Clinic, May 9, 1914. The trouble came in spells, usually, one or two a year, lasting one or two weeks, but more frequent during the last year.

At examination a movable mass was found, not tender nor painful, in the right supraclavicular space. A diagnosis of supraclavicular glands was made.

Operation May 19, 1914, revealed an aneurism of the transverse cervical artery of the right side, which was excised. The patient's convalescence was uncomplicated.

Case III (80527) Mr C H B, aged forty-three, was examined February 24, 1913. He had cut his right wrist with a piece of glass two years previously. A swelling appeared and became gradually larger for one year, then remained stationary.

Examination revealed a pulsating saccular tumor 3 cm over the radial artery just above the right wrist.

At operation March 1, 1913, the radial artery was cut and both ends ligated. The patient was cured.

PROXIMAL LIGATION ONLY (NINE CASES)

Case IV (25528) Mr S E, a colored man aged forty-three, was examined June 29, 1909. He gave a history of having had syphilis when a boy, and of pain in the right shoulder and supraclavicular region for the past six months. Four months before examination he had noticed a pulsating tumor above the right clavicle, which gradually grew larger. The pain became more severe (intense during the last six weeks), and paræsthesia appeared in the thumb and forefinger.

Examination revealed a pulsating tumor in the right supraclavicular region somewhat below the clavicle. The radial pulse was weak in the right arm. The mitral systolic murmur was transmitted to the axilla, the aortic double murmur to the aortic area.

June 29, 1909, a ligation was done of the first portion of the right subclavian artery for subclavian aneurism. The convalescence was uncomplicated.

The patient remained well for three years and three months, when a large aneurism suddenly developed in the first part of the subclavian. The innominate artery was ligated elsewhere.

Case V (3876) Mr J B, aged fifty-eight, at examination November 9, 1907, gave a history of rheumatic pains in the right arm for the last two years, and for the last two months he had noticed a pulsating tumor under the right arm after exertion, more marked during the past month. The hand was numb. The patient had a hacking cough and shortness of breath.

At operation January 4, 1908, the third portion of the right subclavian artery was ligated.

The symptoms persisted and about two months later an attempt was made to remove the aneurism which involved the subclavian and axillary arteries. The operation was completed, except the applying of the proximal ligature to the subclavian, when the patient died of respiratory failure, due to a cerebral embolus which necropsy revealed to have been loosened in the manipulation of the aneurism.

Case VI (3855) Miss E B, aged eighteen, was examined November 18, 1907. Five years previously she had been injured by a pair of scissors driven into the right ear. She had bled severely, and edema of the side of the face followed. For four years she had had throbbing pain in the right side of the face and back of the eye.

Examination showed dilated blood-vessels anterior to the right ear in the temporal region, and extending to the infra-orbital region. Palpable thrill and bruit and visible pulsation were present.

November 21, 1907, the right carotid was ligated for aneurism of the temporal artery. The aneurism was cured.

Case VII (97718) Mr A P, aged sixty-three, came to the Clinic December 27, 1913. One year previously he had noticed stiffness in stretching and some edema of the left leg, and on examination he found a mass in the thigh. The tumor enlarged

SURGICAL TREATMENT OF ANEURISM

gradually and pulsation and pain became marked For the last four months the right knee had been affected The pain was worse at night

Examination showed a large pulsating prominence extending from the femoral region in front, back into the buttocks Palpable thrill was not noted, but bruit over the tumor The tumor was compressible and expansile The right knee was flexed, with some swelling and periarticular thickening The Wassermann test was negative Rontgenograms revealed blurring in the region of the left hip, practical absence of the tuberosity of the ischium and ramus, and an eaten-out area in the posterior third of the lower right femur

A transperitoneal operation was done January 6, 1914, with ligation of the left internal iliac artery for an aneurism about 10 cm in diameter on the inner side of the left thigh The aneurism was thought to be in the obturator artery Thrill was present in the internal iliac but not in the external The ureter and peritoneum were pushed to one side and the vessel was ligated at its origin with two heavy silk ligatures The pulsation ceased immediately The aneurism was stilled when the patient was dismissed from our care a fortnight later

Case VIII (204134) Mrs J E C, aged forty-three, was examined August 6, 1917 For ten years she had had a lump on the left side of the throat which was thought to be due to enlarged tonsils The patient had had goiter for many years Three months previous to examination the mass became larger and began to drain A month later a doctor was consulted who pronounced the condition to be a sarcoma

Examination showed a protrusion of the left pharyngeal wall Thrill internally, bruit externally, and pulsation were noted There was a fusiform swelling of the angle of the jaw on the left without bulging in the larynx A diagnosis was made of adenoma of the thyroid

At operation August 20, 1917, an aneurism of the left external carotid was found The aneurism began just at the bifurcation, and was separated with difficulty from the internal carotid However, the external carotid was ligated with a double strand of silk and a double strand was passed around the common carotid, in case there should be bleeding, this was removed later The convalescence was uncomplicated, and the aneurism was apparently cured when the patient was dismissed from the hospital

Case IX (80021) Mrs R G, aged twenty-six, came for consultation February 14, 1913 Six years previously bleeding from the right ear had commenced and shortly afterward she became deaf and noticed what she supposed to be a growth in the canal of the ear One year later she began to have pain in the ear, and an operation was performed to remove the growth Right facial paralysis that was slight before operation became complete One year after operation the original symptoms reappeared, with severe pain in the head, throbbing, dizziness and fainting spells Occasionally the spells of bleeding from the right ear were severe and lasted several days

Examination revealed a pulsating tumor in front of the right ear, and one of the left submaxillary and carotid regions The patient could open her mouth only slightly A diagnosis was made of an aneurism of the right external carotid artery, and possible aneurism inside the skull involving the right lateral sinus, also aneurism of the left internal carotid extending down to the common carotid

The external carotid artery and the internal jugular vein were ligated on the right February 20, 1913 Six days later the common carotid artery on the left just below the bifurcation was ligated for aneurism, which apparently involved the left internal and external carotids The external and internal jugular veins were ligated The patient made an uninterrupted recovery, and was relieved from the pain, throbbing, and pulsation in the side of the head The bulging was still present

in the left side of the neck two months after the operation, but there was no pulsation. There was still a slight discharge from the right auditory canal.

The patient was heard from one year after operation. She had no signs of a recurrence of the aneurisms.

Case X (81010) Mrs R. B. B., aged fifty-one, had had two attacks of hyperthyroidism, seventeen and four years respectively, previous to examination in the Clinic March 6, 1913. The patient had noticed throbbing in her neck during the last attack, which gradually became worse. An exploration was done elsewhere for aneurism of the thyroid and a diffuse aneurism of the carotid was found. Since then she had had pressure in the neck and a feeling of fullness in the head. For the past six months there had been a dull ache in the right arm. Examination revealed a pulsating aneurism of the right carotid about 3 cm. in diameter, 2.5 cm. above the clavicle.

Operation was performed March 10, 1913, when the middle portion of the right carotid was ligated. Some dilatation followed at the site of ligature, and more below. The patient improved. Slight giddiness still persisted but the dilatation decreased, especially at the upper end. The pulsation persisted.

Case XI (80582) L. H., a boy, aged sixteen, was examined February 25, 1913. Ten years before his right foot had been stepped on by a horse, but there had been no lasting discomfort from the injury. Four years later a painful enlargement appeared in the arch of the foot. This gradually grew worse, at times confining the patient to bed. Some relief was afforded by an arch support.

Examination showed the left foot to be enlarged and puffy, with apparent engorgement of the veins below the ankle. Occasionally a thrill and bruit synchronous with the pulse were present over the inner aspect of the tendo achillis. The right calf measured fifteen inches, the left calf fourteen, the right thigh eighteen and one-half inches, the left thigh sixteen and three quarter inches, the right knee fourteen and one-half inches, the left knee fourteen inches.

March 3, 1913, a ligation was done of the posterior tibial artery and accompanying veins of the varicose aneurism of the left posterior tibial artery above the right ankle.

Repeated examination after operation showed the condition of the foot and leg to be practically the same as before. In twenty-eight days the bruit, thrill and local perspiration were absent. The varicosities in the arch were still present. The patient was forced to wear an elastic bandage. On reexamination two months after the operation the patient was no better. Blood rushed to the leg when he stood, and it was still swollen. Ten months after the operation the condition in the leg was practically unchanged, but thrill and bruit were not present and the swelling was not so marked. Fifteen months after operation the foot was almost normal, but the patient still complained of pain in the leg. Ten days previous to this last report, while the patient was removing the elastic bandage, he felt a sensation as of something giving away in the calf of the leg, with severe pain which persisted. The patient was sent home and told to rest. He returned again in two months, at which time a diagnosis of popliteal aneurism was made and an operation advised which the patient refused.

Case XII (67951) Mrs A. E. B., aged sixty-six, came to the Clinic May 20, 1913, with a history beginning with drooping of the left eyelid three years before, in a few months complete ptosis occurred. The eyeball had been paralyzed completely for the last two years. About six months before examination the patient had begun to have attacks of pain around the left eye and in the cheek and head, with constant pounding in the left side of the head, the attacks lasting from ten to twelve hours. She vomited every few minutes. In the last few weeks there had been a prickling sensation in the lower jaw, in the left side of the tongue, and in the left side of the roof of the mouth.

SURGICAL TREATMENT OF ANEURISM

Examination revealed complete ophthalmoplegia of the left eye, third, fourth, and sixth nerves, and some sensory disturbance of the fifth nerve. The left eyeball was proptosed, the discs were distinctly hazy. Vision in the left eye was 20/40, in the right 20/70. The tonometer showed equal tension in both eyes. The roentgenogram revealed absence of the posterior wall of the sella turcica.

May 27, 1913, a lead clamp was placed on the left common carotid and compressed until a very faint pulsation beyond the clamp was noted. The internal carotid apparently was enlarged to about twice its normal size. Four days later the left common carotid was again partially occluded with the lead clamp which had spread. At a third operation the vessel was completely occluded by placing a forceps on the lead clamp. The common carotid was ligated twenty days after the occlusion with the clamp. The lead clamp had cut entirely through the artery. About 2.5 cm. was cut on either end and the ends ligated. The jugular vein on the left was divided and ligated. The lead clamp was not found. The patient died nine days after the ligation of the left common carotid and the internal jugular vein. Necropsy was not obtained.

LIGATURE ABOUT THE BASE OF THE SAC (ONE CASE)

Case XIII (3724) Mr G W H, aged twenty-four, registered at the Clinic November 13, 1907. Nine years previously he had sustained a buckshot wound in the right groin. An attempt was made at the time to remove the shot. The wound healed in seven weeks, but the region over the wound remained tender. Six months before examination the patient noticed aching of the muscles of the right calf when he walked, and for two weeks he had had difficulty in getting about. Three years before he had had typhoid with phlegmasia alba dolens of the right calf, and ulcers. Since then the right calf had been larger than the left.

Examination revealed an expansile tumor just above the groin on the right, with bruit over the femoral artery, the tumor was visible with expansile pulsation.

At operation November 13, 1907, a saccular aneurism of the right external iliac artery was found. The sac was ligated at the base with No. 4 catgut. The patient's recovery was uneventful. Six years later he was operated on for right hydronephrosis. No signs of aneurism were noted at this time.

MATAS OPERATIONS (FOUR CASES)

Case XIV (48801) Mr G C, aged thirty-four, had been shot with a revolver five weeks before he was examined at the Clinic February 2, 1911. The bullet entered below the knee and came out on the external surface of the middle third of the thigh.

At the time of examination a pulsating fusiform tumor about 8 cm. in diameter was found bound down in the popliteal space. Extension of the leg caused pain beneath the knee. A continuous fine thrill with systolic accentuation on auscultation was heard over the tumor.

A Matas operation was performed February 9, 1911. The aneurism was closed with two rows of chromic catgut. Following the operation the leg swelled slightly, but the swelling disappeared almost completely later and the ulcers healed. The leg swelled again for a time after operation. The patient's condition was much improved.

Case XV (94352) Mr G W, aged forty-two, was examined October 24, 1913. He had had a chancre (?) or lesion on the penis nine years previously, but no secondary manifestations of syphilis. Three weeks before examination he had noticed a small hard pulsating mass in the right popliteal space. Pulsation was transmitted to the foot. The mass increased in size, more noticeably after he had been standing. He had pain down the back of the leg, and some difficulty of extension.

Examination revealed a mass at the right popliteal space, movable with the tissues and with forcible pulsation. Total inhibition Wassermann persisted after three injections of salvarsan.

At operation November 17, 1913, a saccular aneurism at the right popliteal artery was found extending along the artery for about 2.5 cm. There was sufficient good intima in the sac to warrant the reconstructive endo aneurismorrhaphy operation, which was done after the Matas method. At the close of the operation the foot had a good color and the pulse was obtainable in the tibial artery. The leg was in good condition six weeks after operation, when the patient was discharged from the Clinic.

Case XVI (25936) R. S., a boy, aged sixteen, who was examined July 8, 1909, gave a history of having been shot in the left thigh five years before, the wound had healed quickly. One and one-half months before examination rheumatic pain developed in the left ankle, in the knee, and in the region of the wound, and the thigh began to swell. On exertion the leg became numb and dull pain extended from the ankle tumor to the inner side of the knee.

Examination revealed a tumor just above the knee on the inner surface, to be expansile and pulsating. The left anterior tibial pulsation was very faint. There was slight ecchymosis over the tumor. At operation July 8, 1909, an aneurism of the left femoral artery was found in the upper end of Hunter's canal. A large superficial artery running over the tumor was evidently making collateral circulation. A reconstructive operation (aneurismorrhaphy) was done. The opening in the artery was closed with linen sutures. There were no complications and the patient was dismissed on the twenty-second day with the leg in good condition.

Case XVII (141305) Mr. T. A. C., aged twenty-nine, came to the Clinic July 16, 1915. He had been shot in the left leg in the region of the knee eleven years previously, the bullet had been removed. Varicosities had been present since the injury. Seven years later the leg swelled and the veins enlarged and became ulcerated. The swelling and numbness were less at night and when the patient was off his feet. He had worn a rubber stocking for two and one-half years.

An arteriovenous popliteal aneurism was found in the lower left popliteal space, varicose veins of the leg, and scars of former operations for varicose veins.

At operation, September 25, 1915, a sac 5 cm. long and irregularly oblong in shape was found. Into this a dilated vein and a normal sized artery emptied, above and below, making four openings into the sac. The veins were ligated and the artery reconstructed after the method of Matas. The arterial wall was hard and contained small calcareous flakes. The sac was sutured where branches of the artery were torn off from its friable wall.

Following the operation the ulcers persisted for eight months, and there was slight numbness of the leg. Thrill was noted with extreme flexure. On the whole the patient was greatly improved.

SILK FIGURE-EIGHT SUTURE ABOUT ANASTOMOSIS (ONE CASE)

Case XVIII (159911) Mr. I. A. M., aged thirty-five, was examined at the Clinic May 17, 1916. He had been shot with a thirty-eight caliber revolver in the upper right chest nine years previously. Very severe hemorrhage occurred, and the patient was in a hospital for three months. There had been more or less constant swelling and gradual development of varicosities of the left arm. For the past two or three months there had been swelling of the forearm, and frequent cramps, especially when the arm was used. The swelling under the clavicle did not increase.

The left arm and shoulder were found to be greatly swollen, the veins in the left axilla and the chest wall were varicose. Under the left clavicle, 10 cm. from the midline, a soft pulsating tumor was palpated. Thrill was noted and a loud systolic murmur was heard over the tumor.

SURGICAL TREATMENT OF ANEURISM

Operation was performed May 23, 1916 The pectoralis was removed The left subclavian vein was distended to about 5 cm in diameter from the sterno-clavicular angle out into the arm The vein was doubly ligated proximal to the subscapular vessels All the veins which acted as arteries had greatly thickened walls The superficial vessels were ligated between the sternoclavicular angle and the point of ligation of the subclavian vein A figure-eight compression suture was placed over the point of arteriovenous anastomosis, which is about 4 5 cm from the left sterno-clavicular angle Hemorrhage was severe on account of the bleeding from both arteries and veins Two tube drains were inserted The arm before operation was about twice the normal size, blue and congested, with veins standing out over the left side of the chest, the left shoulder, and arm Following the operation there was a marked change, the swelling was reduced one-half during the first twenty-four hours and the condition of the arm improved steadily The patient was discharged one month after the operation able to use his arm

PARTIAL EXCISION OF THE SAC AND SUTURE OF OPENING IN ARTERY (ONE CASE)

Case XIX (232671) Mr H K, aged thirty-eight, fifteen months before examination in the Clinic May 29, 1918, had been shot at close range with a twenty-two caliber rifle The bullet entered the thigh 10 cm above the knee on the median surface, and passed out, posterior to the bone, at a corresponding level on the outer surface Some hemorrhage had occurred and the patient was in bed for two weeks with the leg greatly swollen back of the knee Later the lower leg and foot became swollen, and about nine months after the injury the skin became darkened and eczematous, and several small ulcers appeared

The leg presented the typical symptoms of an arteriovenous aneurism Just above the external condyle was a soft pulsating swelling, the size of an egg, and in the center of it the wound of exit Expansile pulsation with a marked thrill and venous hum over the mass and marked diffuse swelling of the popliteal space were present The dorsalis pedis on both sides was palpable, but the posterior tibial vein at the ankle was not found The aneurism was stilled by compressing the femoral artery in Hunter's canal

Operation was performed June 6, 1918 An oblique posterior popliteal incision was made The popliteal veins 2 5 cm in diameter were isolated and separated above and below the anastomosis of the artery to the vein In passing a ligature around the anastomosis the sac was pricked, which caused considerable hemorrhage An effort was then made to ligate with silk, but because the anastomosis was large it was impossible to close it in this manner The sac, which was on the venous side and opposite the opening between the artery and the vein, was dissected out and part of it cut away The opening between the artery and vein, about 2 5 cm. in length, was closed by suture with catgut The vein was ligated distally with silk, and without drainage Following the operation there was complete cessation of pulsation, thrill and bruit, and in twenty-four hours the swelling had greatly decreased The dorsalis pedis was palpable The patient was able to use his leg when he was discharged from the hospital fifteen days after operation

APPLICATION OF NEFF OCCLUSION CLAMP (TWO CASES)

Case XX (61582) Mr C F B, aged twenty-eight, who was examined November 27, 1911, had been operated on elsewhere six years before for right inguinal hernia For the last year the patient had had a throbbing sensation in the right abdomen about 5 cm above the hernial wound Three weeks before examination, and occasionally since, when he lifted any weight, he had had a sharp, stabbing pain above the hernial scar Otherwise he felt well

When the patient was examined, a pulsating mass in the lower abdomen, slightly to the right side, was noted The pulsation in the right femoral artery was normal, in the left it was absent, bruit was felt over the mass The lower abdominal veins were enlarged The right leg was somewhat larger than the left

TABULATION
DATA ON TWENTY-ONE CASES OF ANEURISM

	Case	Artery involved	Type of aneurism	Operation	Results
I	76029	Obturator, left	Traumatic	Proximal and distal ligation with partial excision of sac	Cure Anomalous origin obturator artery
II	105740	Transverse cervical, right	Pathologic	Proximal and distal ligation with excision of sac	Cure
III	80527	Radial, right	Traumatic	Proximal and distal ligation with excision of sac	Cure
IV	25528	Subclavian, right	Pathologic	Ligation first portion subclavian artery	Well three and one-fourth years, then sudden recurrence
V	3876	Subclavian, right and axillary	Pathologic	Ligation third portion right subclavian At tempt at excision 2 months later	Death, on attempt at excision, due to cerebral embolus from sac
VI	3855	Superficial temporal, right	Arteriovenous	Ligation external carotid	Cure
VII	97718	Obturator (?), left	Pathologic	Proximal ligation internal iliac artery	Cure No signs of aneurism sixteen days post-operative
VIII	204134	External carotid, left	Pathologic	Proximal ligation external carotid	Cure
IX	80021	External carotid, right Internal carotid, left	Pathologic	Proximal ligation, right external carotid Ligation right internal jugular vein Proximal ligation left common carotid and left internal and external jugular veins	Cure No recurrence one year later

SURGICAL TREATMENT OF ANEURISM

X	81010	Common carotid, right	Pathologic, diffuse	Proximal ligation common carotid artery	Improvement
XI	80582	Posterior tibial, left	Pathologic (?), diffuse	Proximal ligation posterior tibial artery	No improvement
XII	67951	Internal carotid and cavernous sinus, left	Arteriovenous	Lead compression clamp to internal carotid artery Occlusion artery completed four days later Ligation common carotid and internal jugular vein twenty-eight days after occlusion internal carotid artery	Death from cerebral changes nine days after last operation
XIII	3724	External iliac, right	Traumatic, saccular	Ligature No 4 catgut tied about base of sac	Cure Patient well six years after operation
XIV	48801	Popliteal, left	Traumatic	Matas obliteration, endoaneurismorrhaphy	Improvement of leg Some swelling
XV	94352	Popliteal, right	Pathologic, saccular	Matas reconstructive operation	Cure Leg in good condition
XVI	25936	Femoral, left, in Hunter's canal	Traumatic	Matas reconstructive operation	Cure
XVII	141305	Popliteal, left	Arteriovenous	Matas reconstructive operation Ligation popliteal vein	Cure Some numbness
XVIII	159911	Subclavian, left third portion	Arteriovenous	Silk figure-of-eight suture about anastomosis	Cure Swelling disappeared
XIX	232671	Popliteal, left	Arteriovenous	Partial excision of sac and suture opening in artery	Cure
XX	61582	Common iliac, right	Pathologic (?), saccular	Neff clamp to common iliac proximally	Death from circulatory disturbance 4 days post-operative
XXI	62336	Femoral, left	Pathologic, diffuse	Neff clamp to left common iliac artery	Improvement of swelling Reduction of swelling

December 29, 1911, an extraperitoneal working incision and an intraperitoneal incision for exploration was made. A saccular aneurism which started at the beginning of the common iliac artery was found. A Neff occlusion clamp was set on the right common iliac 2.5 cm above the beginning of the aneurism, the clamp was closed down to very faint pulsation below. The sac of the aneurism occupied nearly the entire pelvis and interfered with the circulation in the left leg. The patient vomited for the first twenty-four hours. The pulse was 130 for several hours after the operation and then varied between 130 and 162. The color of the right leg was good for two days, but the pain in it was severe. The patient died, probably of circulatory disturbances, the fourth day after the operation.

At necropsy a large saccular aneurism of the right common iliac artery, beginning about 6 cm below the origin of the common iliac and extending to about the beginning of the femoral was found. The Neff clamp was in place 3 cm below the bifurcation of the aorta.

Case XXI (62336) Mr G M, aged twenty-seven, came to the Clinic December 16, 1911. Eleven years before he had had a sudden onset of severe pain above the left knee, the region became red and swollen. The patient was confined to bed for six months. Four months after the onset of the pain an incision was made with the evacuation of pus, but the pain continued. At the end of four months the bone was scraped. The wound healed, but the leg above the knee swelled. The patient thought that a large vessel in the leg had been injured or cut at the second operation. Ulcers had appeared, but they healed in six weeks. Eight weeks before examination the patient began to have pain, more severe after standing, in both sides and above the knee.

Examination revealed a varicose condition above and below the knee, the leg and knee were slightly swollen. A rough bruit was felt and heard in the popliteal and adductor regions, with pulsation in the posterior tibia and anterior tibia at the ankle.

At operation December 28, 1911, a diffuse dilatation of the entire left femoral artery, extending beyond Poupart's ligaments, was found. The incision in the thigh was closed and eleven days later an abdominal exploration (transperitoneal exposure) was done. A Neff clamp with several rolls of catgut, held together with a rubber elastic, was placed on the left common iliac artery at its origin. The peritoneum was stitched over the clamp. Following the operation a tuberculous abscess developed at the site of the old osteomyelitis scar. This was drained and cleared up. Chills and high temperature had preceded the appearance of the abscess. The patient had improved at the end of two and one-half months, but the thrill was still present and some swelling of the leg.

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TRANS-ORBITAL PUNCTURE OF THE GASSERIAN GANGLION*

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DIRECT injection of the fifth cranial nerve has been so closely associated with the therapy of trigeminal neuralgia, that their histories are almost identical. Indeed, this procedure has but one competitor in the treatment of the disease. The contest for supremacy between "chemical neurectomy" and operative neurectomy has been fought for thirty-five years. Although operative neurectomy is undoubtedly the method of choice at present, a conservative view must concede the possibility that further observations and improvements in the technic may reverse this decision.

In any event, as a stimulus to further development of needle puncture of the trigeminus, we have the problem of nerve block anæsthesia for operations on the head, face and buccal cavity. Although the development of intratracheal insufflation anæsthesia has reduced enormously the mortality of operations in these regions, elaborate apparatus is required and the method is seldom employed. It is to be hoped, therefore, that any effort to improve and simplify the technic of the injection of the trigeminus will be valued not only for the help it may afford in the therapy of trigeminal neuralgia, but also because of its obvious usefulness in nerve block anæsthesia for the difficult technical operations within the zone of distribution of the fifth nerve. Indeed, this is probably its most fruitful field of usefulness.

HISTORICAL

In tracing the history of needle puncture of the trigeminus we find three developmental stages—first, a time when injection was made into the peripheral branches of the nerve, second, a time when the operator became more daring and directed his needle to the main nerve divisions at the base of the skull, and finally, a time when the needle was passed into the Gasserian ganglion itself, in order that the nerve cells might be infiltrated. Rynd (1840) was responsible for the first peripheral injection. He advocated the use of morphine and creosote for this purpose. The result was not sufficiently striking to secure the introduction of the method, and the procedure had to await the discovery of a drug better adapted to this purpose than creosote. A great many were tried and rejected, and it was not until 1874 that this form of therapy became firmly established by Bartholow with the injection of chloroform. Osmic acid was then used by Billroth (1884), Neuber (1884), Eulenberg (1884) and Schapiro (1885). The technic was simple but the results quite uncertain, and it was frequent to get disfiguring

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scars due to tissue necrosis At best, relief from pain was no more lasting than that resulting from nerve avulsion For a period attention was diverted from injection therapy to extirpation of the ganglion by open operation, elaborated by the brilliant work of Hartley, Krause and Cushing There was little doubt as to the efficiency of gasserectomy in the permanent relief of neuralgia, but the operation as executed in those days was subject to an almost prohibitive mortality from hemorrhage and shock

The second stage of trigeminal puncture was inaugurated by Schlosser (1903), director of the Eye-clinic in Munich By investigations upon cadavers, he elaborated a technic whereby a needle could be inserted through the cheek to the foramen ovale at the base of the skull And he used this technic for the injection of alcohol into the mandibular division in two hundred cases of trigeminal neuralgia (1906 and 1907) In his hands the treatment was easily administered and the relief fairly certain, but the method required the knowledge of a trained anatomist and the skill of a specialist for its execution With the way thus opened, there soon appeared other methods for needle approach to the basilar foramina, chief among which were the technics of Ostwalt (1906) and of Levy-Baudouin (1906) Whereas, Schlosser had been able to inject the third division only, Ostwalt, by entering the needle through the mouth, was able to reach in succession in a single puncture the foramen ovale, the foramen rotundum and the sphenoidal fissure, and thereby to apply treatment to any of the three primary divisions of the trigeminal nerve This, too, required great skill in its management, and in addition was open to the danger of septic inoculation from the mouth Levy and Baudouin employed separate punctures for each of the three divisions Their technic is the one practiced most widely at present for this purpose

No matter how thorough the injection of one of these nerve trunks and how complete the resulting anæsthesia, in a large percentage of cases sensation returns from eight to ten months after treatment, for, although death of the peripheral nerve segment is produced by the alcohol, continuity of the nerve sheaths is not disturbed, and regeneration readily occurs Consequently an effort was soon made to destroy the nerve cells by injection of the Gasserian ganglion, the third stage in the history of trigeminal puncture Wright (1907) exposed the foramen ovale by open operation in an obstinate case of facial neuralgia, and passed a needle through the foramen into the ganglion Chollin (1907), using the Ostwalt intrabuccal technic upon the cadaver, succeeded in entering the foramen and placing an injection of methylene blue directly in the ganglion As a result of experiments upon the cadaver, Byrnes (1909) modified the methods of Schlosser, Ostwalt and Levy and Baudouin in such a manner that by use of any one of them the Gasserian ganglion might be reached But none of these investigators applied their work clinically, and it is to Pussep (1911) that credit is due for being the first to place alcohol in the Gasserian ganglion of a living subject by transcutaneous needle puncture The experi-

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ment was very nearly fatal to the patient, for vomiting, cyanosis, bradycardia and collapse immediately followed the injection—and the operator, aghast at the picture presented, denounced the procedure as far too dangerous for justification. Perhaps this unfortunate experience might have delayed the progress of Gasserian puncture, had it not been for an accident on the part of Taptas (1911), of Constantinople. While attempting to inject the third division of the trigeminal nerve at the foramen ovale by the Levy-Baudouin approach in a case of tic douloureux, Taptas inadvertently slipped the needle through into the ganglion and injected alcohol. The result was profound anæsthesia in the entire trigeminal field and permanent relief from pain. The patient suffered no ill effects. And we find in the literature shortly after this, descriptions of two methods completely elaborated upon cadaver and living subject, whereby the needle may be made to enter the ganglion. The first of these is the invention of Wilfred Harris (1912), Physician to Saint Mary's Hospital, London, and is based upon the original Levy-Baudouin approach to the third division. Fritz Hartel (1913 and 1914), of Berlin, is responsible for the second, which is in principle none other than the puncture of Schlosser. Both Harris and Hartel used the foramen ovale as a pathway to reach the ganglion. These are now the classical methods for intraganglionic injection.

THE HARRIS TECHNIC

Harris described his method as follows: "I use a moderately stout, hollow needle 12 mm in diameter, with a short point, without a stylet. This is pushed through the cheek below the zygoma, on a line joining the ala nasi with the incisura notch of the ear, and about $1\frac{1}{4}$ inches in front of this notch. If pushed in horizontally the point of the needle will sometimes strike the ramus of the mandible just below the sigmoid notch, but depressing the handle of the needle slightly will allow the point to slip through the lowest level of the sigmoid notch into the zygomatic fossa. Directing the needle slightly upwards and backwards the base of the skull will be reached at a depth of about $1\frac{1}{4}$ inches, the point of the needle striking the under surface of the great wing of the sphenoid. The handle of the needle must then be depressed and the point of the needle be made to slide along the bone until it engages in the foramen ovale, at a depth usually of $1\frac{3}{4}$ inches. In some skulls the needle must be directed more upwards, as high as 30 degrees upwards, and in others it must be directed at the same angle backwards. If this needle is pushed in too horizontally the wall of the pharynx will be pierced at a depth of from 2 to $2\frac{1}{2}$ inches, or again if it be pushed too far through the foramen ovale, the cavernous sinus and internal carotid artery will be punctured. To avoid this the needle should never be passed through the foramen to a greater depth than $2\frac{1}{2}$ inches from the surface." "As soon as the needle touches the nerve at its exit from the foramen ovale, as indicated by a sharp pain referred to the lower jaw, 0.5 c.c. of a 2 per cent solution of novocain is injected to test the position of the needle, before alcohol is used (1.5 c.c. of 90 per cent alcohol). Fluid thus placed in the foramen ovale usually flows upwards a variable distance along the nerve trunk into the Gasserian ganglion, and infiltrates the root of the third division. "But if the second division is also affected by the pain, then more of the ganglion must be destroyed and the needle must be worked through the foramen into the substance of the ganglion to the depth of another quarter of an inch. A drop of alcohol is

then cautiously injected, considerable resistance to the push on the piston being experienced if the point of the needle remains within the new tissue. Another 10 to 15 cc of alcohol should then be injected, a few drops only at a time, at intervals of not less than two minutes, meanwhile testing the sensation of the cheek and forehead with a blunt pin. When neither the pressure of the head of the pin or the sharp prick on the forehead is any longer perceived at all, enough has already been done and the needle should be slowly withdrawn." General anæsthesia is not used. The skin at the point of entrance is anæsthetized by local infiltration or by freezing.

THE HÄRTEL TECHNIC

The following account is translated from Hartel's (1913) article "An assistant steadies the head of the patient. The operator places his left forefinger in the patient's cheek, and with the jaw closed searches for the fissure between the maxillary tubercle and the ramus of the mandible. With the marker of the needle adjusted at 6 cm, the needle is passed into the cheek at a point 2 cm lateral to the angle of the mouth, until it comes in contact with the hard, smooth surface of the infratemporal plate. Now the finger is removed from the cheek, the marker on the needle has come to lie on the cheek surface. The marker is withdrawn a distance of 1.5 cm from the skin as an indicator of the further depth required. With the face of the operator directly over the up-turned face of the patient, the needle should be situated in a plane passing through the pupil on the same side. Now the needle is grasped as though it were a pencil, and by repeated partial retractions and insertions, search is made backwards along the bony surface. One should not travel with the needle point more posteriorly than that angle at which the needle is directed toward the auricular tubercle of the zygoma. What was up to this point a painless procedure now becomes painful, for we are approaching the vicinity of the third division and its branches. After a few trials here and there against the surface of the skull, the needle passes over the anterior rounded margin of the foramen ovale and is no longer confronted by bony resistance, but instead by the dense consistency of the nerve tissue filling the foramen. It is advanced into the skull until the marker is brought flush with the skin surface (an intracranial distance of 1.5 cm). If bony resistance continues to offer, either the needle is in the foramen ovale but in a wrong axis to enter its canal, or it has travelled posteriorly onto the inferior surface of the petrous portion of the temporal bone (Eustachian tube). Draw the needle out immediately and repeat the puncture at a new point of entrance or in a different axis. With the needle supposedly in the ganglion substance, 0.5 cc of 2 per cent novocain solution is injected, in order to test the accuracy of the puncture and to guard against the serious consequences of alcohol placed elsewhere than in the nerve. If the desired trigeminal anæsthesia is the result, alcohol injection is begun slowly with careful watch for loss of corneal reflex, the first sign of a successful ganglion injection. During the process of the injection the needle point is worked about in the ganglion substance, to secure as thorough an infiltration as possible." Hartel uses for this puncture a hollow steel needle 10 cm in length and 0.8 mm in diameter, without a stylet. This needle is quite flexible, its advantage over the heavier needle of Harris lies in reduced damage to the tissues. However, its flexibility makes lateral movements impossible, and search for the foramen must consist in a succession of punctures.

Nine years have elapsed since these two prevailing methods of needle puncture of the Gasserian ganglion were first attempted clinically. They have both been used in this country in the treatment of tic douloureux by Grinkler (1913), Maes (1913), Camp (1914), Byrnes (1915), Vaughan

(1917) and many others. In reviewing the literature that has accumulated one cannot help but be impressed with the diversity of opinion held by competent men as to the facility with which ganglion puncture is performed. There are those who find but little difficulty in placing the needle within the ganglion. Dorrance (1916) states that he "gets in the first or second time, and it comes easy after doing a few." Martin (1918) feels that "the injection of the ganglion of Gasser through the foramen ovale for the relief of trigeminal neuralgia has passed beyond the experimental stage and will eventually supersede surgical extirpation of the ganglion, division of the sensory root, peripheral and nerve trunk injection, and other more or less unsatisfactory procedures." But the majority hold more regard for its uncertainties and dangers, and a few are so pessimistic as to pronounce it utterly unjustifiable. Patrick (1916), who has had a very considerable experience with injections into the divisions of the nerve, expresses but little enthusiasm in regard to ganglion puncture. "I must say that under the rules Hartel himself originated, I never had the courage to attempt to inject the Gasserian ganglion. Injection of the ganglion by the Harris method is disappointing to me. I have tried it a number of times, occasionally the needle goes through the foramen and reaches the Gasserian ganglion or its vicinity with a facility comparable to putting one's hand in one's pocket. And the next time the needle does not find the foramen at all." There is no easily recognized pathway to the foramen. The operator must depend upon the sense of direction only in passing his needle through the soft tissues of the cheek and zygomatic fossa to bone 4 to 7 cm beneath. He aims to hit a target whose average diameters are 3.5 and 6.6 mm. A deviation of but three degrees is necessary to deflect the needle point from the centre of the foramen onto the adjacent surfaces. On account of the variations to be found in normal skulls chances of a hit are even less than this. It has been found, for instance, that the distance of the foramen ovale from the zygoma may show a variation of more than a centimetre. Often an attempt to enter the ganglion becomes little else than a hunt in the dark. Moreover, the practice of probing along the base of the skull in quest of the foramen is not simple, for, as Patrick (1912) points out, "the under surface of some skulls is very uneven and the irregular and unnamed processes serve to confuse the operator, he feels bone everywhere." When the needle has entered the foramen successfully and is passing on into the ganglion, there is nothing to indicate its exact position within the skull, except the patient's statements in regard to his sensations, or trial injections of novocain, or arbitrary rules as to depth. Movements of the needle within the ganglion are not always represented in an accurate manner by pain referred to the surface, nor is the patient able in every case to describe his sensations adequately. Test injections serve as an accurate sign of a successful puncture, but on the occasion of an unsuccessful attempt such a preliminary injection must necessarily render the tissues less sensitive and mask the signs relied upon for further search. Hartel directs that the needle point be carried

15 cm beyond the foramen for a correct localization in the ganglion, and Harris that the depth should be but a few millimetres. These rules cannot be reliable. Hartel (1913) himself has shown by measurements upon sixty skulls that the foramen ovale is not simply an aperture but a canal of variable length, that the distance of the lower margin of the ganglion from the foramen ovale may vary as much as 10 mm, that the superior margin of the petrous portion of the temporal bone lies anywhere from 14 to 23 mm beyond the foramen. Moreover, the Gasserian ganglion is a very much flattened structure, and is so situated that its narrow margin is presented to a needle entering the foramen ovale. Should the needle be introduced in a plane nearer to the vertical than that of the ganglion, it may readily enter the foramen, but instead of proceeding on into the ganglion, it will enter the subarachnoid spaces above it. Or should the needle pass in a plane nearer to the horizontal, it will probably burrow beneath the ganglion capsule, where injection may be made without effect.

Not only are these two methods uncertain in execution, but there are dangers to be considered. The zygomatic fossa is crowded with important soft structures. It has a rich blood supply from the internal maxillary vessels. The middle meningeal artery enters the cranium by way of the foramen spinosum only 2 mm lateral to the foramen ovale, and might easily be pinched against the bone and ruptured by the needle point. Ecchymosis and œdema of the cheek and neck is a common occurrence, and cases are met with, in any considerable series of punctures, which develop large disfiguring hæmatomata, a source of annoyance to both patient and operator. The Eustachian tube lies in a groove on the under surface of the skull about 5 mm posterior to the foramen ovale. Its cartilaginous wall offers a degree of resistance to the needle point which is scarcely distinguishable from that encountered during passage of the foramen, and, particularly where it is the custom to inject a few drops of novocain before introducing alcohol or where the entire procedure is carried out under general anæsthesia, there is danger of infiltrating the middle ear with alcohol. Cushing (1920) reports a case of a woman, who had undergone such an accident and came to him suffering not only with an unrelieved trigeminal neuralgia but with the agony of a middle and internal ear necrosis. She ultimately died of meningitis. So strong a tissue fixative as concentrated alcohol may do much damage not only at the point of injection, but at a distance by spreading along fascial planes. Cushing (1920) has witnessed locking of the temporo-mandibular articulation, sloughing of the nasal bones and fibrosis of the pterygoid muscles with traction of the jaw to one side. As the needle passes into the skull, according to the method of Harris, it is directed toward the internal carotid artery, and a mistake in depth of one or two centimetres means puncture of that vessel. This is highly improbable when the rules of the technic are faithfully observed and under favorable conditions, but the possibility cannot be eliminated and is discomfoting, to say the least. Neugebauer (1918) accidentally punctured the internal carotid in this way, with

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immediately fatal results The dangers surrounding infiltration of the ganglion itself with alcohol are discussed below

A large amount of work has been expended in an effort to overcome the uncertainties and eliminate the dangers of ganglion puncture *via* the foramen ovale, and as a result there has accumulated a most interesting assortment of schemes for this purpose Resort was first had to the natural bony landmarks of the skull For instance, it has been pointed out that the external pterygoid plate and the lateral surface of the maxillary tuberosity lie directly anterior to the foramen ovale and may be used as indicators of the depth of the foramen from the cheek Thus, Braun (1920), in using the Harris approach, recommends that a preliminary puncture be made to ascertain the depth of the pterygoid plate, and with this as a guide a second puncture in quest of the foramen Offerhaus (1910) employs the maxillary tuberosities for this purpose He measures inside the mouth the distance separating the tuberosities and subtracts this from the interzygomatic diameter The remainder divided by two represents the depth of the foramen from the zygoma Hertzler (1920) has attempted to simplify Hartel's method by employing the following rule "Locate the parietal eminence (of the opposite side of the head) with the thumb and the external occipital protuberance with the third finger, while the index finger makes a point midway between the two landmarks The needle enters the cheek opposite the upper second molar and is then passed directly toward the index finger which is located as described above" Attempts have been made to estimate the depth of the foramen ovale from the surface by use of the interzygomatic diameter alone With observations upon a large number of skulls Patrick (1912) formulated a rule, that when the interzygomatic distance is five inches, the foramen is at a depth of 4.0 to 4.25 cm, when the interzygomatic distance is five and one-half inches, the foramen is over 4.5 cm from the surface of the cheek To the same end Smith and Neil (1920) subtract 1 cm from the interzygomatic diameter and multiply by nineteen-sixty-fourths They apply this rule in conjunction with a mechanical needle-director, an instrument based upon geometrical principles calculated to guide the needle through the foramen ovale into the ganglion The method necessitates a double puncture Byrnes (1915), too, has invented an instrument somewhat of this nature Employment of the fluoroscope in ganglion puncture has been suggested by Pollock and Potter (1916) In order that the foramen be readily located on the screen, a lead catheter is passed into the Eustachian tube as a preliminary measure The method offers considerable promise as a means of directing deep cranial punctures, but at present is of little practical value, for the X-rays are deflected so diversely, in their passage through the bony planes of the skull, as to distort the needle pathway and render its recognition difficult

In reviewing these carefully conceived inventions and many more which are described in the literature, one cannot help but be impressed with the ardor and ingenuity which have entered into their creation Surely the pur-

pose must be well worth seeking. But any method of approach to the ganglion through the foramen ovale is lacking in two important respects. There is no natural, easily followed pathway leading to the foramen, and there is no limiting boundary to indicate the proper depth of penetration. Could the needle be passed with but a single thrust, and were there certain means of knowing when the needle point has reached its goal, then ganglion puncture would be robbed of a great many of the dangers now attending it. Where neighboring anatomical landmarks have failed to guide the needle adequately, mechanical devices have been employed, but the human body is not built according to the principles of mathematics, and it is folly to attempt to fathom its spatial relations by such means. Patrick (1912) has attempted to express the degree of accuracy attained in his injections. He says "I have made about 500 deep injections. Of these, for the inferior branch (third division), about 27 per cent have been misses, 45 per cent partial successes, and 28 per cent good." These figures have to do not with individual insertions of the needle, but with sittings, moreover, the object sought was injection of the bifurcating nerve trunk at its exit from the foramen, at all odds a simpler problem than penetration of the foramen. When only one-quarter of his attempts at the third division proves successful, surely an operator with less experience than his could not hope to place a needle in the ganglion itself by this route with as great success.

It is for the purpose of presenting a hitherto untried avenue of needle-approach to the Gasserian ganglion which will satisfy those two primary requirements and at the same time remain within the boundary of reasonable safety, that this paper is written. The approach is the orbit, the path followed is the medial orbital wall, and the portal of entrance to the cranial cavity the sphenoidal fissure. The needle is guided by sense of touch along a smooth bony surface, until its progress is obstructed by the bony fossa lodging the Gasserian ganglion.

ANATOMY

We are concerned with the anatomy of the medial wall of the orbit, the sphenoidal fissure and the middle cranial fossa. (See Figs 1 to 8.)

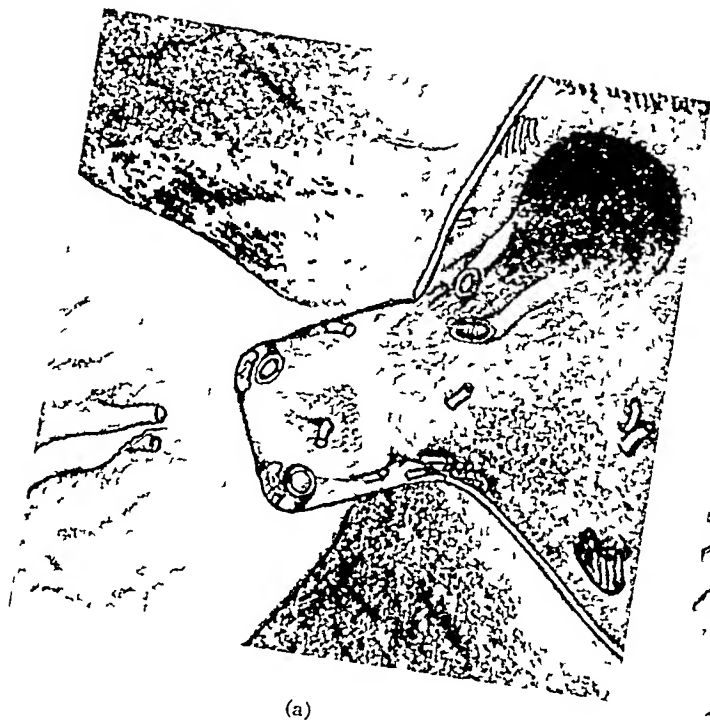
The medial wall of the orbit is a smooth, flat surface directed in an antero-posterior plane. Its anterior extremity becomes continuous with the root of the nose, and presents above a small depression for attachment of the pulley of the superior oblique muscle and below a groove occupied by the lachrymal sac. The internal tarsal ligament is attached at a point just below its centre, and marks the upper limit of the lachrymal sac. Between the internal tarsal ligament and the superior oblique pulley the surface of the bone is occupied by no structures of importance. The medial wall of the orbit slopes away into the orbital roof above and into the orbital floor below, and leads posteriorly into two apertures connecting the orbit with the medial cranial fossa, an upper, the optic foramen, for transmission of the optic nerve and ophthalmic artery, and a lower, the sphenoidal fissure, for transmission of the other structures which enter the orbit. The upper margin of the orbital wall is pierced by two foramina for passage



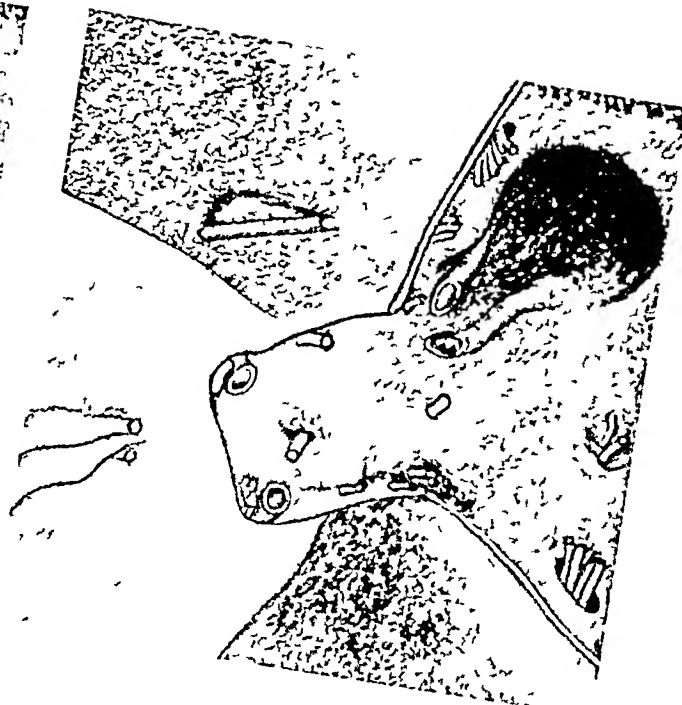
FIG 1--Anterior view of the right orbit indicating the first portion of the needle path



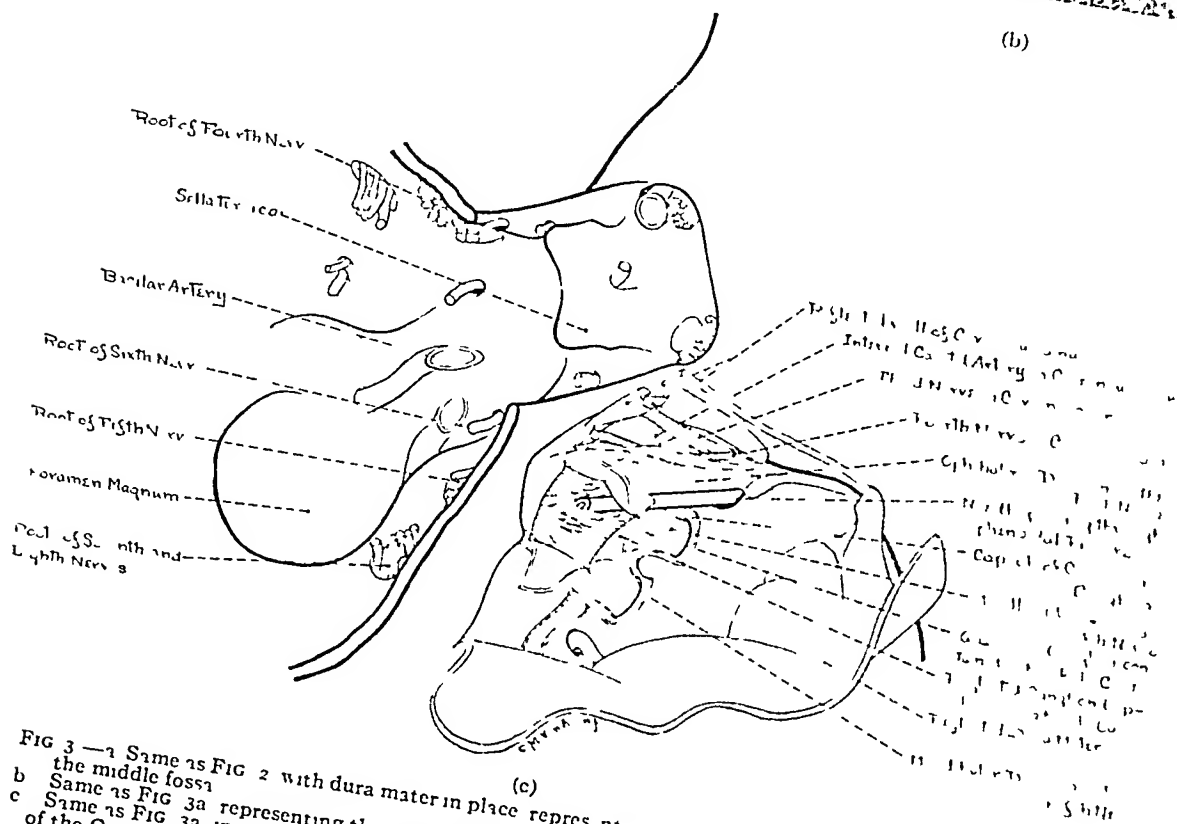
FIG 2 —Right lateral view of the interior of the skull indicating the last portion of the needle path in the middle fossa. The needle point lies in the fossa Grasser.



(a)

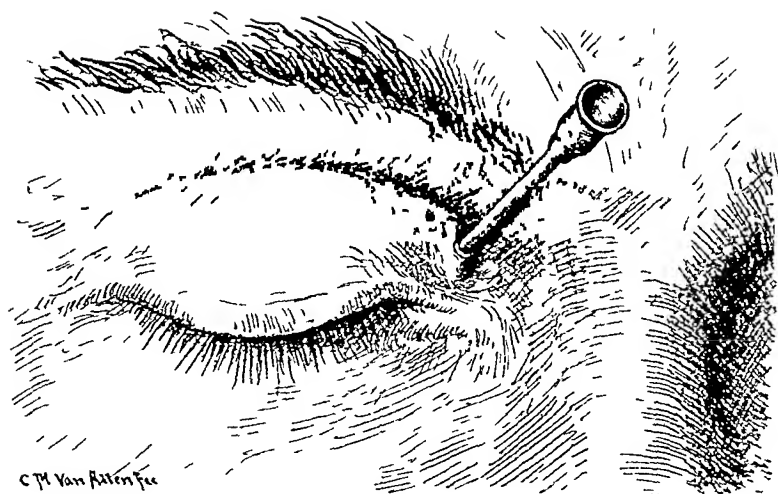


(b)

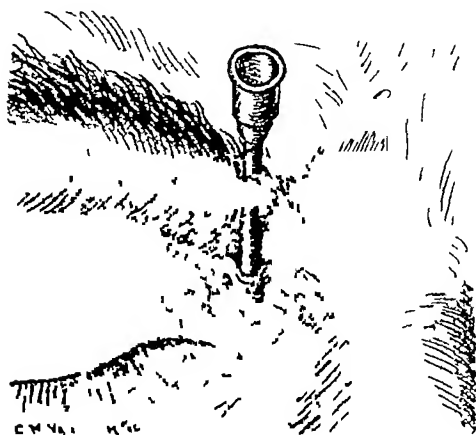


(c)

FIG 3 — a Same as FIG 2 with dura mater in place representing the subdural course of the needle through the middle fossa
 b Same as FIG 3a representing the transdural course of the needle through the middle fossa
 c Same as FIG 3a in outline with the dura mater of the middle fossa reflected representing the relations of the Gasserian ganglion and the puncture needle



(c)



(b)



(a)

FIG. 4 — a The author's needle used in puncture of the Gasserian ganglion (greatly enlarged)
 b The right eye illustrating the first direction taken in inserting the needle
 c The right eye illustrating the position of the needle when the ganglion is reached

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of the ethmoidal nerves and vessels. Otherwise its surface is occupied only by loosely applied periosteal lining, over which plays the medial rectus muscle. The medial orbital wall is formed chiefly by the ethmoid, and aids in enclosing the ethmoidal air sinuses.

The sphenoidal fissure is a narrow opening obliquely situated in the back of the orbit and opening through the anterior wall of the middle cranial fossa. Its lower or medial extremity is at the level of the floor of the orbit. The tendon of origin of the lateral rectus muscle is so arranged as to bridge across the sphenoidal fissure and to divide it into two compartments. The upper of these compartments transmits all the structures of the fissure, the lower contains fat and connective tissue only.

The middle fossa of the skull encloses the temporal lobe of the cerebrum. It is bounded anteriorly by the greater and lesser wings of the sphenoid, posteriorly by the petrous portion of the temporal bone, and medially by the body of the sphenoid. On the anterior surface of the petrous portion of the temporal bone there is a shallow excavation, the fossa Gasseri, for lodgment of the Gasserian ganglion. This fossa is so situated that it faces forward and will intercept a straight line drawn along the medial wall of the orbit, commencing at the pulley of the superior oblique muscle and extending through the lower extremity of the sphenoidal fissure. The portion of this line between the sphenoidal fissure and the fossa Gasseri marks the situation of the lateral wall of the cavernous sinus. The sinus wall is composed of dura matter which is separated into two layers by nerve trunks passing forward to the orbit. These nerves are four in number, the oculomotor above, the trochlear next, and below the first and second divisions of the trigeminal. Between this wall and the body of the sphenoid is an interval of about 1.5 cm occupied by the cavernous sinus, through which run the internal carotid artery and the abducent nerve. (See Fig 8)

The trigeminal nerve leaves the pons beneath the tentorium and runs forward over the apex of the petrous bone, pushing a diverticulum of dura with it from the posterior fossa beneath the dura lining the floor of the middle fossa. This diverticulum is known as Meckel's cave. Here the sensory portion of the nerve takes on a ganglionic enlargement (Gasserian ganglion. See Fig 3c). The limiting boundary of the cave of Meckel is indicated on the surface of the dissected ganglion as a semicircular line demarcating the root of the ganglion from its body, and giving to it the name of semilunar ganglion. That portion of the trigeminus contained within the cave is made up of loosely grouped fibres and consists for the most part of nerve axons on their way to the brain. The cerebrospinal fluid of the posterior fossa finds ready access to Meckel's cave and bathes the nerve contained within it. The major part of the ganglion is situated under the dura just beyond the limits of the cave, it is of firm texture and encased in a fibrous capsule. The ganglion gives rise to three nerve trunks, the first and second passing forward between the two layers of the wall of the cavernous sinus to enter the sphenoidal fissure and the foramen rotundum, respectively, and the third passing downward to enter the foramen ovale.

With this hasty review of the regional anatomy, we may better understand the pathway taken by the needle. This path is that of the line mentioned above, passing through the orbit, sphenoidal fissure and middle cranial fossa to the Gasserian ganglion. The needle is guided through the orbit by following its medial wall backwards to the sphenoidal fissure. It is separated from the delicate structures of the orbit by the medial rectus muscle, and in the sphenoidal fissure it occupies the lower compartment

which contains no nerves or vessels. These relations are to be seen in Figs 5 and 6. The direction given the needle in passing through the orbit determines its route through the middle cranial fossa. Accordingly, as the orbital wall varies in position, so the needle's course beyond it will be made to vary and will pursue any one of four routes. Thus, upon leaving the sphenoidal fissure, it may enter between the two layers of the lateral wall of the cavernous sinus, and travel thus posteriorly into the Gasserian ganglion (Fig 8, right side), it may take up a more lateral course and traverse the temporal lobe cortex before reaching the ganglion (Fig 8, left side), it may pass more medially and transfix the cavernous sinus en route to the ganglion, or, finally, it may run so far medially as to terminate within the sinus and never reach the ganglion. By whichever of these routes the needle may pass, it is brought to stop by the petrous portion of the temporal bone, and can go no further.

TECHNIC

The instrument used in this puncture is the Patrick cranial needle, purchasable at any of the standard instrument companies, 10 cm in length and $1\frac{1}{2}$ mm in diameter, equipped with a closely fitting stylet. The point is ground back 3 or 4 mm, in order that the stylet may protrude a short distance. Thus, when the stylet is in place, the instrument becomes a blunt-pointed probe, when withdrawn, there remains a sharp-pointed hollow needle. This instrument is illustrated in Fig 4a.

The patient is placed in a dorsal-recumbent position, and the operator stands at his head. The upper inner angle of the orbit and the medial orbital wall, as far as can be reached with a small hypodermic needle, are infiltrated with 1 per cent novocain solution. With the finger-tip placed well under the orbital arch, search is made for the pulley of the superior oblique muscle, felt as a small hard knob upon the surface of the bone. A 3 or 4 mm incision is now made just below this pulley and carried through the skin and fascia to the bone beneath (Fig 4b). With the knife tip the periosteum leading into the orbit is loosened to a distance of 0.5 cm. Bleeding is controlled by pressure. The needle with the stylet in place is grasped between the thumb and forefingers as in holding a syringe, and its blunt point is inserted within the incision underneath the periosteum against the surface of the bone. Passage is now commenced in a direction backwards and towards the mouth. In this direction the medial wall of the orbit is soon felt to slope away laterally into the floor. Feeling with the blunt needle point and using the upper inner angle of the orbit as a fulcrum, the junction of wall and floor is followed posteriorly through the orbit to a depth of about one-half the needle's length, when a bony obstruction is reached. This obstruction is the lower margin of the sphenoidal fissure, and serves the useful purpose of indicating that the posterior extremity of the orbit has been reached. The needle point is lifted over this margin and passed into the fissure. Now a pause is taken to make sure of two things—first, that the shaft of the needle

is held firmly against the upper inner angle of the orbit, and, second, that the tip of the needle is lodged within the lower extremity of the sphenoidal fissure. These two points establish definitely the further course of the needle. The stylet is withdrawn, and the needle is driven straight through the middle cranial fossa until blocked by bony resistance. By this sign, as well as by complaint on the part of the patient of trigeminal pain, it is known that the Gasserian ganglion is reached, and injection may be made (Fig 4c).

In making the puncture the following practical points should be emphasized.

Should the preliminary loosening of the periosteum at the margin of the orbit be not extensive enough, some difficulty will be experienced in starting the needle upon its journey, for here the tarsal fascia is firmly attached to the bone. It is better to reinsert the knife and free the periosteum to a further extent, than to force the needle. Once started the needle travels with but little resistance along the medial wall of the orbit. Because of rough manipulation or an unusually thin orbital plate, the needle may break through the medial orbital wall and come to lodge within the ethmoidal air sinus beneath. Such an accident is appreciated by the premature obstruction which it causes, and is remedied by withdrawing the needle a short distance and replacing it in its correct channel. The needle point is made to travel along the line of junction of the medial wall with the floor of the orbit, because thereby it is carried directly to the lower extremity of the sphenoidal fissure and is prevented from wandering upwards onto the medial orbital wall, where it would inflict damage to the ethmoidal vessels, or laterally onto the floor of the orbit where it would encounter the inferior orbital fissure. The lower margin of the sphenoidal fissure varies considerably in prominence. In the great majority of cases it can be easily recognized and easily surmounted, occasionally it cannot be felt, and the only indication of the position of the needle is the added resistance of the tissues occupying the fissure, while at times the margin is so outstanding as to cause difficulty in orientation. However, in any case, it is only necessary to move the needle point cautiously upwards, to discover the lower extremity of the sphenoidal fissure. The orbital portion of the route requires a dull-pointed needle to facilitate palpation, and here, accordingly, the stylet is used, but behind the sphenoidal fissure palpation is no longer necessary and the stylet is discarded, in order that with the sharp point the tough planes of dura in this region may be cut cleanly through. The exact depth of the Gasserian ganglion from the surface by this approach varies considerably (8.5 to 10.0 cm) and bears little significance in the performance of the puncture, for reliance is placed upon the skull surfaces to guide the needle and to stop it when the ganglion is reached. As regards discomfort caused by the puncture, it can be said that the preliminary novocain infiltration controls the first portion of the route completely, but the moment the fissure is passed the patient complains bitterly of pain referred to the inside of the head (dura) and to the trigeminal field.

This part of the puncture is performed rapidly and the pain is relieved by immediate injection of novocain

Ganglion puncture by the orbital route involves certain dangers. Rupture of the medial wall of the orbit by the needle point might lead to contamination of the needle, should the underlying sinus be the seat of infection. It is unnecessary to suggest that under such conditions further introduction of the needle should be abandoned. In over half of the cases it has been demonstrated that the needle traverses the cavernous sinus on its way to the ganglion. It might be expected that such injury to the wall of the sinus would lead to hemorrhage within the skull. However, one cannot compare the great venous spaces of the dura to veins elsewhere in the body, for the skull is a rigid box with an internal tension produced by the rise and fall of arterial pressure. The venous blood returns at a pressure well below this. Accordingly, under conditions of maintained intracranial tension there could be no extravasation of blood from an injured sinus wall into the surrounding medium. Invasion of the cavernous sinus might result in thrombosis. But such a thrombosis would be aseptic, and except for temporary disturbance of circulation in regions drained by the sinus and the possibility of pulmonary embolism, it is difficult to conceive of injurious consequences. Sometimes the needle's path lies through the temporal lobe cortex, but this is a so-called silent region of the brain, and no ill effects need be expected. In a small percentage of cases the needle does not reach the ganglion, but terminates within the cavernous sinus. This fact can be recognized immediately upon removal of the stylet, for venous blood flows slowly from the needle. When this occurs, of course, injection of alcohol is contraindicated. The internal carotid artery lies 0.5 to 1.0 cm medial to the sphenoidal fissure and is thus effectually sheltered from injury in all cases, except where, because of aneurismic dilatation, it may occupy an abnormal position. The needle is guided to its destination by the natural bony planes of the skull. Failure to reach the ganglion is due to unusual variation of these planes and cannot be remedied by meddlesome probing. The needle can do no harm in its prescribed channel, but it does not have to wander far afield to inflict serious damage. A good rule to adhere to in the use of this puncture is never to make a second attempt, when the first properly applied is unsuccessful.

LABORATORY INVESTIGATION

Anatomical study of this method of Gasserian ganglion puncture has been carried out as follows

Upon twenty-four cadavers available in the dissecting rooms of the Department of Anatomy, Yale School of Medicine, bilateral Gasserian punctures and injections with methylene blue were performed. After each injection a strand of wire was inserted in the needle bore and allowed to remain as an indicator of the pathway followed. Careful dissections were then made in each case to study this pathway and to determine the behavior of the injected fluid. The results of this investigation are summarized thus

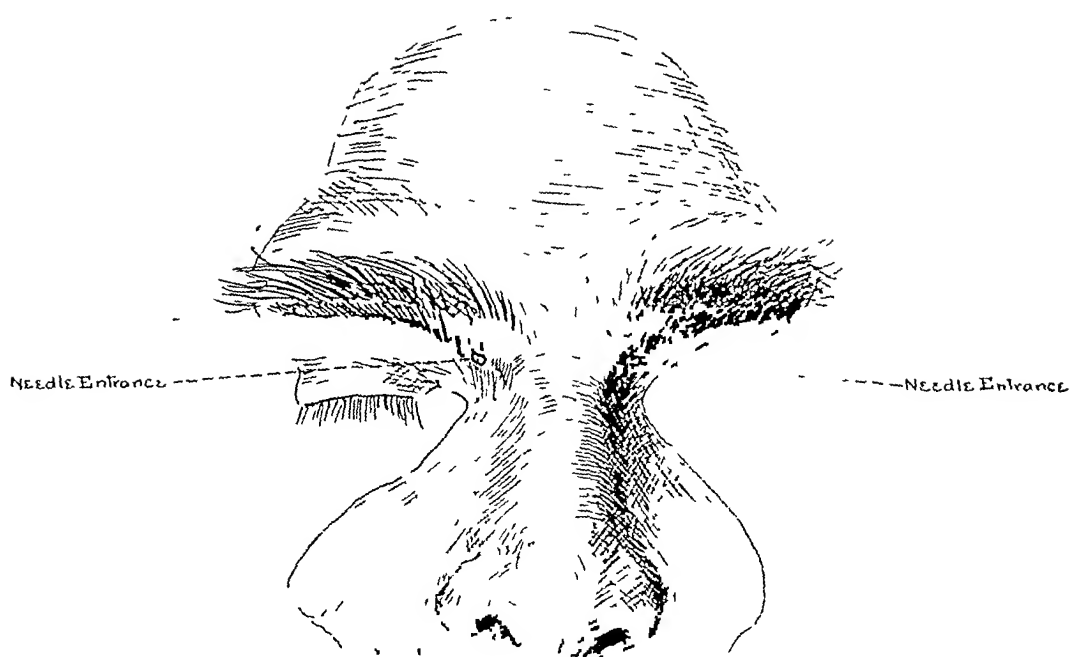
PUNCTURE OF THE GASSERIAN GANGLION

Material	25 cadavers	<div> <div>White, 23</div> <div>Colored, 2</div> </div> <div> <div>Male, 21</div> <div>Female, 1</div> </div>
Number of punctures performed	50	<div> <div>Successful, 41</div> <div>Unsuccessful, 9</div> </div> <div> <div>Adult male, 5</div> <div>eight-year female, 2</div> <div>microcephalus, 2</div> </div>
Pathway taken by the needle		<div>Through sphenoidal fissure, 47</div> <div>Through foramen rotundum, 2</div> <div>Cranium not entered, 1</div>
Depth of sphenoidal fissure from the nasal bridge		<div>Maximum depth, 7.2 cm</div> <div>Minimum depth, 5.0 cm</div> <div>Depth of greatest frequency, 6.8 cm</div>
Depth of Gasserian fossa		<div>Maximum depth, 10.0 cm</div> <div>Minimum depth, 8.5 cm</div> <div>Depth of greatest frequency, 9.3 cm</div>
Trauma to medial orbital wall		<div>Broken through, 6 (all of which occurred among the first 15)</div> <div>Crackling of the bone felt, 11</div> <div>No injury, 33</div>
Recognition of inferior margin of sphenoidal fissure		<div>Margin felt, 40</div> <div>Margin not felt, 9</div>
Passage of needle in relation to dura mater		<div>Beneath dura, 39</div> <div>Dura punctured, 10 (of which 8 occurred among the first 9)</div>
Passage of needle in relation to cavernous sinus		<div>Sinus entered, 14</div> <div>Sinus not entered, 35</div>

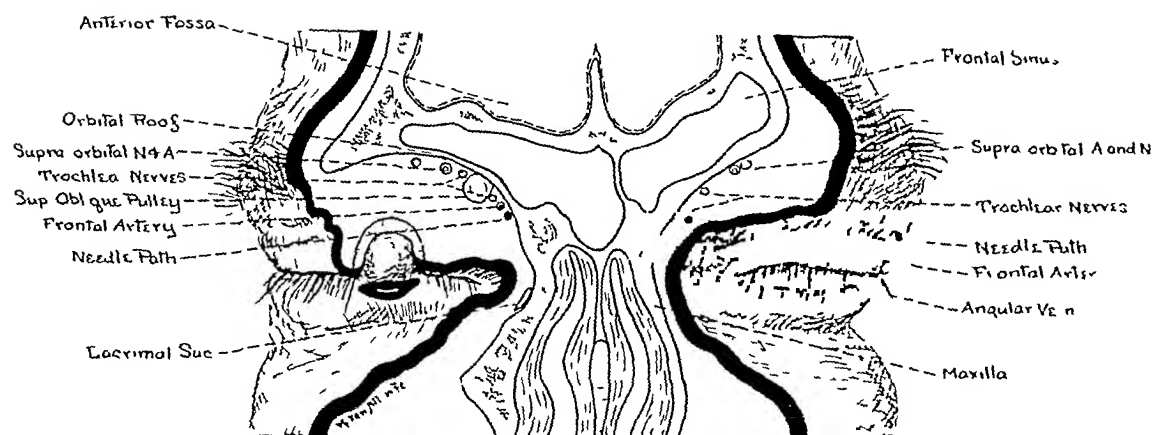
Difficulty encountered in passage of needle	{	Easy passage, 39
		Slightly difficult, 10
		Passage impossible, 1
Nature of fluid injected	{	Alcoholic solution of methylene blue, 23
		Aqueous solution of methylene blue, 27
Behavior of fluid injected	{	Complete infiltration of the ganglion, 38
		Partial infiltration of the ganglion, 3
		Infiltration into the cavernous sinus, 4
		No fluid injected, 5

Upon a well-preserved human head bilateral Gasserian puncture by the orbital route was carried out, and, instead of wire, broom-straws were left to occupy the needle path. The specimen was then frozen and sawed in serial sections taken in a frontal plane. By study of these sections, each with its fragments of broom-straw *in situ*, an exact determination of the position of the needle was obtainable at intervals of 0.5 to 1.0 cm throughout its course from the skin to the ganglion. Outline tracings of these sections are reproduced in Figs 5, 6, 7 and 8. It so happened that in this specimen the needle on each side followed a different pathway in the middle cranial fossa. On the right side the needle passed between the layers of the wall of the cavernous sinus, and on the left side through the temporal lobe cortex. These are two of the four ways that may be taken, as have been pointed out above.

Of particular interest in this experimental work was the behavior of the injected stain. In the great majority of cases the needle entered the root of the ganglion contained in Meckel's cave, and the first two or three drops of fluid injected filled the cave and saturated the nerve in it. The body of the ganglion lying outside of the cave was free from stain, as well as other structures in the neighborhood. In the remaining successful punctures the needle lodged in some part of the ganglion itself. Fluid deposited here had no opportunity to spread throughout the ganglion but almost immediately followed the path of least resistance upwards into the cave of Meckel, where it saturated the nerve root. In other words, the procedure is primarily an injection of the ganglion root. Every fibre of the nerve passes through the cave and is involved. There is a feature which needs emphasis and careful consideration. This is the fact that Meckel's cave can hold only a few drops of fluid and any excess flows freely backwards along the nerve trunk into the subarachnoid cistern at the base of the brain. Such an event is inevitable when fluid is injected into the Gasserian ganglion by any method in quantity greater than 0.5 cc. Many instances are on record of ganglion puncture by technics of Harris and Hartel, which presented undoubted

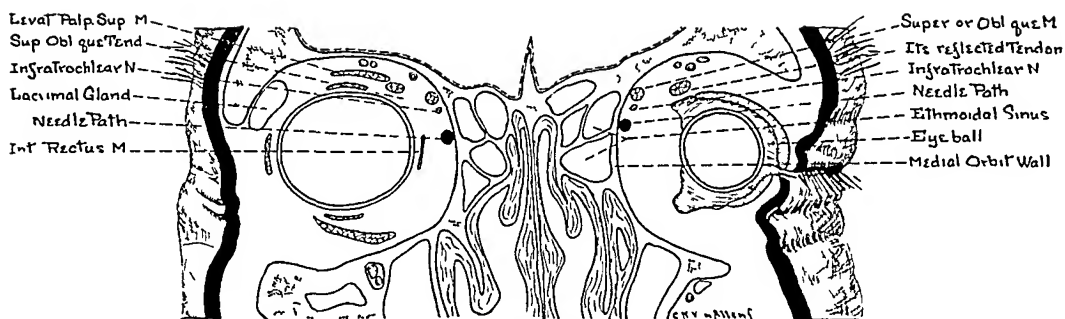


Surface Section
Indicating Points of Needle Entrance

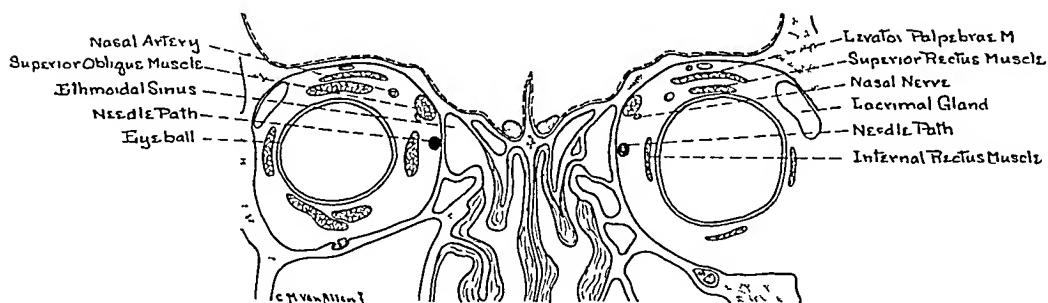


Section through Frontal Sinuses
1.1 cm Depth

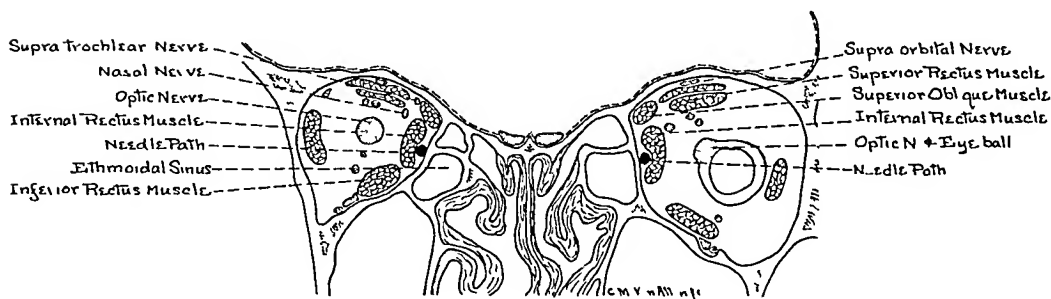
FIG 5 —Tracings of the first two of a series of frozen sections taken in a frontal plane throughout the pathway of the needle. The rest of the series are represented in FIGS 6, 7 and 8 arranged in a ventro dorsal sequence. Solid dots indicate the position of the needle in each section.



Section Through Anterior Orbits
2 cm Depth

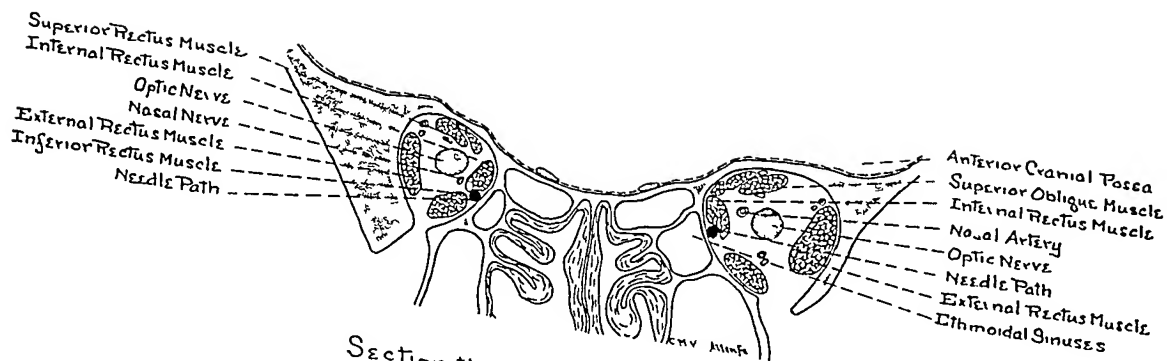


Section through Middle Orbits
2.9 cm Depth

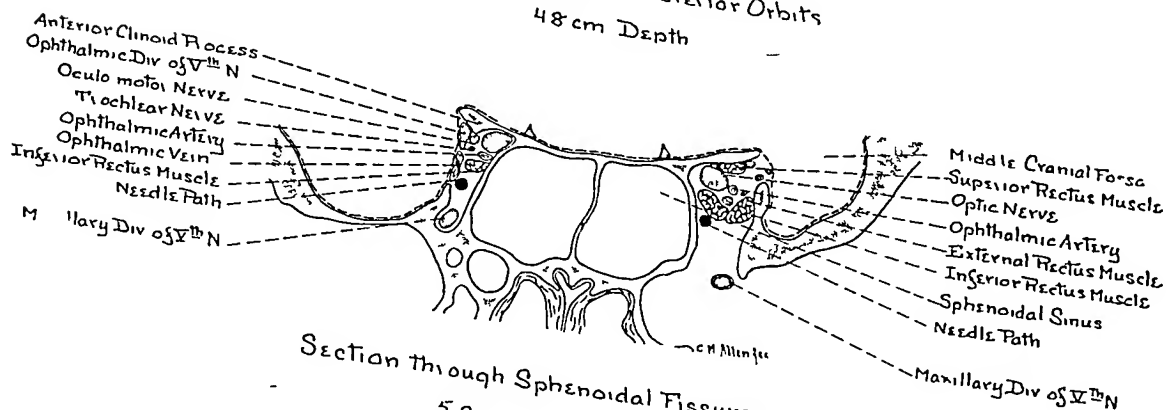


Section through Posterior Orbits
3.9 cm Depth

FIG 6 —Tracings of the third fourth and fifth of the series of frozen sections



Section through Posterior Orbits
48 cm Depth



Section through Sphenoidal Fissures
59 cm Depth

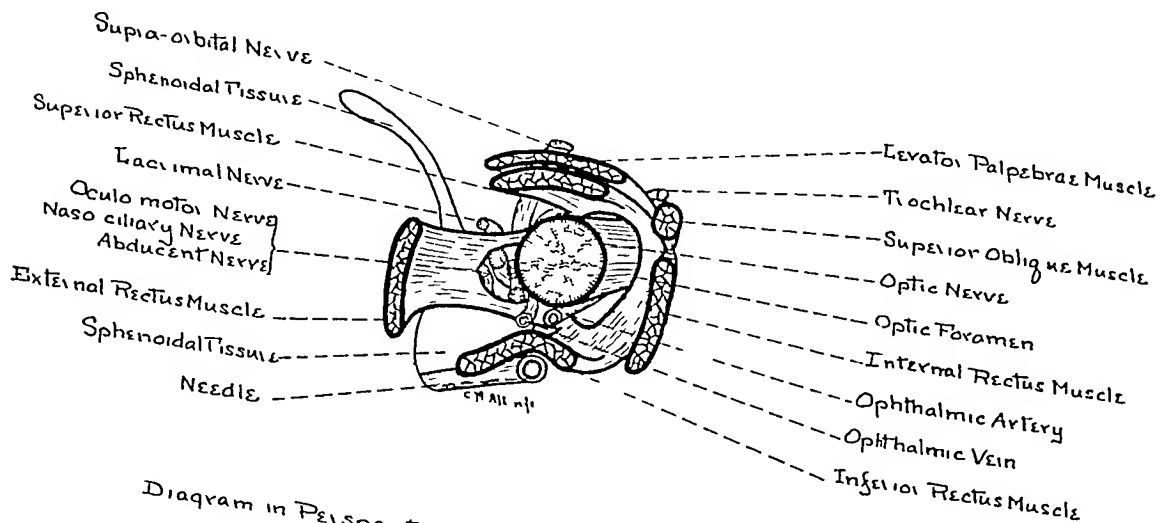
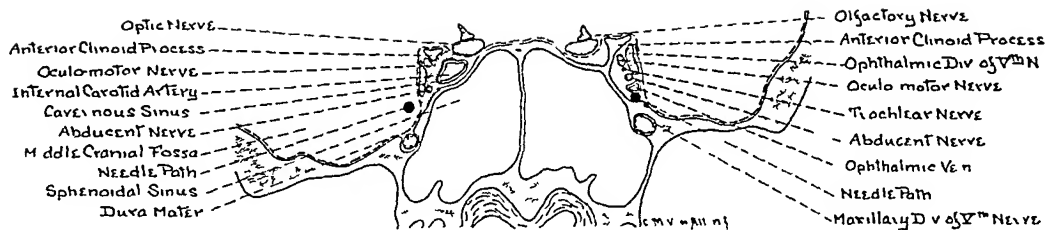


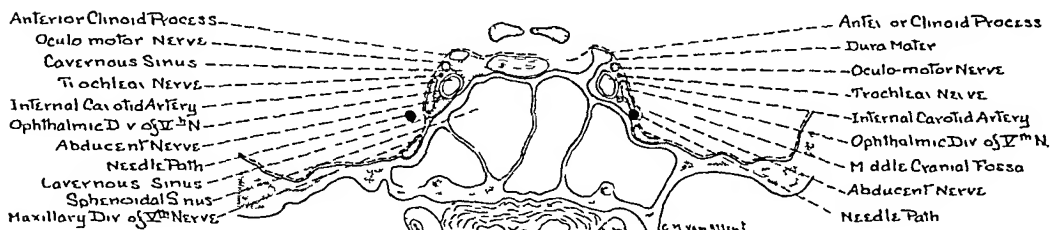
Diagram in Perspective Illustrating Needle Passage through
Posterior Orbit and Sphenoidal Fissure (Right)

FIG 7 — Tracings of the sixth and seventh of the series of frozen sections



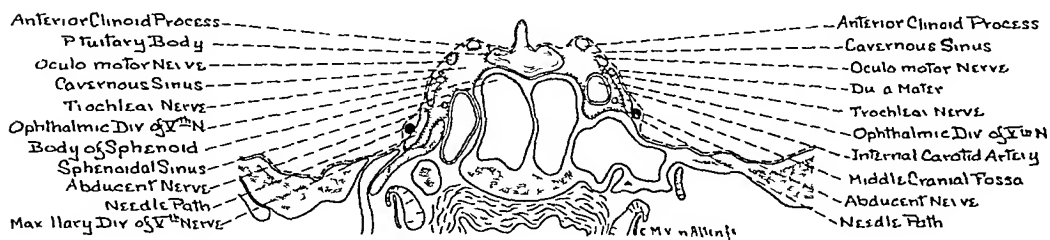
Section through Cavernous Sinuses Anteriorly

66 cm Depth



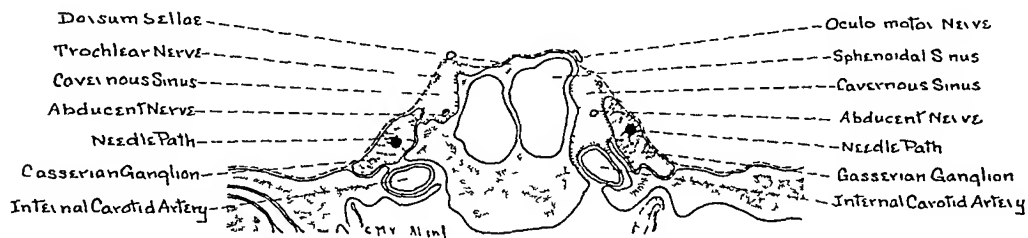
Section through Cavernous Sinuses Anteriorly

74 cm Depth



Section through Middle of Cavernous Sinuses

80 cm Depth



Section through Cavernous Sinuses and Gasserian Ganglions

86 cm Depth

FIG 8 — Tracings of the eighth ninth tenth and eleventh of the series of frozen sections

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symptoms of irritation of the structures in the basilar cistern, principally of the third, fourth, sixth, seventh and eighth cranial nerves. This liability offers the one serious objection to alcoholization of the Gasserian ganglion.

To sum up the results of cadaver experimentation—of fifty-two consecutive punctures, forty-three have been shown to enter and successfully infiltrate the ganglion root. Of the remaining nine, two upon a microcephalus and two upon a child of eight years may be eliminated, for they did not have to do with normal adult skulls. Five punctures were failures—four because the needle terminated within the cavernous sinus, and one because for some unascertained reason the sphenoidal fissure could not be found. We may conclude, then, that from an anatomical standpoint the technic shows an efficiency of about 90 per cent.

Attempt has been made to investigate the physiological effects of the puncture by experiment upon lower animals. The regional anatomy of the dog, rabbit and monkey were studied with the hope that an animal could be found which would present conditions comparable to those found in men. Puncture of the ganglion was carried out in the dog, but in order to enter the sphenoidal fissure at a proper angle the needle had to pass directly through the orbital fat, and so much hemorrhage resulted that no valuable conclusion could be drawn, and the attempt was abandoned. The monkey gave better promise, for its orbit is almost identical with that of man. Accordingly a *Macacus* monkey was secured and operated upon with the aid of general anæsthesia. The result of the puncture was almost instant death. Autopsy showed that on both sides the needle had entered the internal carotid artery. Possibly some other species of monkey would be better adapted to the experiment, but further investigation of this nature offered little of value.

CLINICAL APPLICATION

Without adequate proof of the innocuousness of the puncture, it was felt that an application to the living subject in the clinic could be justified only in those cases where no less hazardous means is known of preventing a fatal outcome of disease. Such circumstances are often found in malignant disease of the face. These patients are usually aged and infirm and very poor subjects for general anæsthesia. The tumor is frequently too deeply seated to allow of local infiltration anæsthesia, ganglion block alone can accomplish the purpose. We have applied the method first of all in just such extreme cases.

CASE REPORTS

CASE I—The patient, a white female, ninety-four years of age, came for treatment January 14, 1921, suffering from basal-cell epithelioma of the superior orbital margin. The tumor was of three months' duration. It had invaded the orbit and was giving increasing pain. The extreme senility of the patient forbade the use of general anæsthesia, and the situation of the tumor ruled out the use of local infiltration. January 16, 1921, by the aid of 1 per cent novocain infiltration of the inner angle of the orbit, a transorbital puncture was carried out and the Gasserian ganglion injected with a few drops of 5 per cent cocain solution.

There developed almost immediately a complete anæsthesia of the trigeminal field on that side, and under its influence the tumor was excised, together with the underlying periosteum and the eyelid. The defect was covered by skin flaps taken from the scalp, the incision extending upwards almost as far as the coronal suture. The patient suffered not the least discomfort from operative manipulations. Except for mild nausea and vomiting occurring at the close of operation and referable to the cocaine, there were no constitutional disturbances and but little shock. The wound healed rapidly and recovery was without incident.

CASE II—The patient, a white male, sixty years of age, came under observation March 19, 1921, with a rodent ulcer of the cheek, four months' duration. One X-ray and seven radium treatments had produced no effect. Examination showed an indurated ulcer of the right cheek extending from the angle of the mouth to the masseter muscle. It had perforated into the mouth at two places, and involved the alveolar processes of both upper and lower jaws (Fig 9). No metastasis was made out. At operation, March 21st, the needle was passed through the orbit into the ganglion. Upon removing the stylet spinal fluid exuded from the needle. One and five-tenths c.c. of 4 per cent novocain solution was slowly injected. The needle was left in place. The external carotid artery was ligated under local anæsthesia to control hemorrhage. Then operation upon the face was carried out in the following steps: Thorough cauterization of the ulcer margins, division of the lower lip, chin and symphysis in the median line, division of the mandibular ramus, partial resection of the superior maxilla, and, finally, removal in a single specimen of the entire ulcerated mass, together with the body of the mandible and a portion of the alveolar process and body of the maxilla. This left a gaping defect in the side of the face. The buccal cavity was then closed off by suture of the mucous membrane of the side of the tongue to that of the hard palate. The wound was left open to allow of free drainage and control of infection in preparation for grafting at a future date. The anæsthetic effect of ganglion block began to wear off twenty-five minutes after the injection, and an additional 2 c.c. of 4 per cent novocain were required. Except for the region of the midline, which receives partial supply from the opposite trigeminal nerve, and the angle of the jaw, supplied by the cervical plexus, the field of operation was insensitive. Recovery to date has been uneventful. A roentgenogram, taken directly after the operation with the needle still in place, is reproduced in Fig 10. (This photograph has been retouched and serves only as a diagram to indicate the position of the needle within the skull.)

CASE III—The patient, a white male, age seventy-nine years, was admitted to the surgical service of the New Haven Hospital February 3, 1921, for treatment of a basal-cell epithelioma of the lower lip, duration two months. In addition he had been a sufferer from attacks of angina pectoris for a number of years, and he presented signs of active pulmonary tuberculosis, of aortic aneurysm and of advanced arteriosclerosis. Blood Wassermann, 4-plus, blood-pressure, 185/110. A preliminary resection of the submental glands was done under local infiltration anæsthesia, March 1st, and four weeks later, March 31st, a portion of the lower lip containing the tumor was excised and the defect closed by plastic operation under the influence of Gasserian ganglion block. The needle was introduced through the orbit in the usual fashion. Upon withdrawal of the stylet spinal fluid flowed from the needle. Two c.c. of 2 per cent novocain solution were injected. It was found that this strength of novocain produced a profound anæsthesia of the nerve but only of from three to five minutes' duration. Consequently the needle was left in place and small injections were made from time to time (one- to two-minute intervals) throughout the opera-

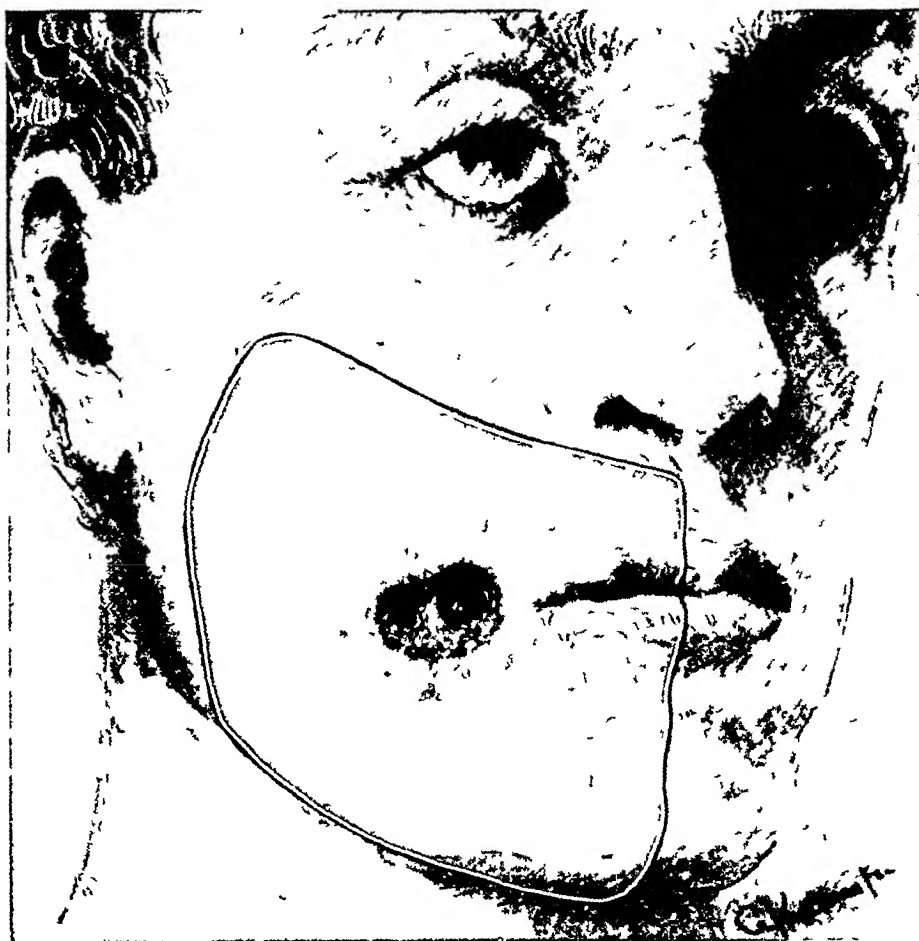


FIG 9 —Case II Sketch illustrating the lesion and the outlines of the specimen removed at operation



FIG 10 —Case II Röntgenogram lateral view of the skull with the needle in place



FIG 11 —Case V Photograph taken three days after alcohol injection for trigeminal neuralgia The pencilled line indicates the boundary of the anæsthetic zone produced by the injection

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tion In all, approximately 20 cc of 2 per cent novocain was used Absolutely no ill effects were experienced either during the operation or upon return to the ward Recovery presented no complications

CASE IV—The patient, a white male, seventy-one years of age, had suffered with severe paroxysms of pain in the second and third divisions of the left trigeminal nerve for six years During this time he had received seven injections into the branches of the nerve at the base of the skull The first treatment gave him relief for nearly a year Each repeated injection was less effective, and the last two produced no result whatever. When he was first seen the paroxysms were occurring at intervals of about three minutes The patient presented the picture of uniform senile degeneration without grave constitutional defect On April 21, 1921, transorbital puncture was done The needle entered without the slightest difficulty and was guided into position in a perfectly normal fashion When the stylet was removed a stream of blood flowed slowly from the needle A few drops of novocain were injected, but no anæsthesia resulted and the needle was immediately withdrawn There were no ill effects from the puncture Three days later the Gasserian ganglion was removed by open operation At this time a search was made for any signs of hemorrhage following the puncture of the cavernous sinus, but no evidences were visible in the field of operation

CASE V—The patient, a white female, sixty-four years of age, came under observation May 3, 1921, suffering with neuralgia of the third division of the left trigeminal nerve, six years' duration Paroxysms occurred at intervals of from one to two hours, and lasted ten or fifteen minutes They were excited by any disturbance of the lower jaw, as in chewing or talking The mouth had not been cleansed for years for fear of the terrible pain such an act would cause She had received palliative treatment without benefit May 4, 1921, a transorbital puncture was carried out Spinal fluid escaped freely from the needle, and was allowed to flow to the extent of 15 or 20 cc Five-tenths cc of 4 per cent novocain solution was injected for the purpose of testing the accuracy of the puncture, and in a few minutes there resulted an anæsthesia of all three divisions Then 1 cc of absolute alcohol was slowly injected The patient responded immediately by vomiting The pulse was of good volume and rate, and there was nothing to cause alarm About ten minutes after the first injection 1 cc of alcohol was added, and again in ten or fifteen minutes 0.5 cc was injected, making in all 2.5 cc of absolute alcohol Each injection was followed by vomiting, and for a period of one-half hour after removal of the patient to the ward there was distressing nausea No further constitutional disturbance was noted As an immediate result of the injection the eyeball on that side was rendered completely immobile, the pupil two-thirds dilated and the eyelid ptosed One hour later it was noticed that the movements of the eye were gradually returning and the pupil was nearer its normal size At this time there was evidence of an orbital œdema, which in six hours developed sufficiently to close the lids There developed, too, a moderate local ecchymosis Upon discharge from the hospital five days after operation there was no return of the tic, the entire left trigeminal field was anæsthetic and there was a residual paralysis of the superior rectus and levator palpebræ superioris muscles The œdema was subsiding On the ninth day the patient was seen again and it appeared that the neuralgic pain had returned in full force However, the symptoms were either psychic or totally misrepresented, for at repeated examinations, the last ten weeks after injection, the patient complained of nothing other than tingling and smarting sensations at the margins of the anæsthetic zone This zone was as extensive and insensitive as that obtained at first The oculomotor paresis had disappeared, and there was no evidence of serious trophic disturbance of the

cornea A complete left facial paralysis made its appearance during the second week Very fortunately this was not of a permanent nature, for in a few days it showed signs of clearing, and at the last examination activity had returned to the majority of the facial muscles Strange to say the eighth nerve has not been impaired The photograph, Fig 11, was taken of the patient on May 7th The boundary of the anæsthetic area is indicated by a line drawn upon the patient's skin This area extends to the vertex of the head and internally to include the left half of the anterior two-thirds of the tongue, the left half of the palate and the left nasal fossa It corresponds within the limits of anatomical variation with the field of anæsthesia which has been shown to follow gasserectomy in Cushing's (1904) review of his first twenty-six cases

In these five cases, three males and two females, the ages varied between sixty and ninety years The right side was punctured twice and the left three times The needle was introduced without the slightest difficulty in recognition of the pathway, and was halted at the proper depth by the petrous portion of the temporal bone In four cases the technic was successful in producing anæsthesia of the entire trigeminal field In one case (Case IV) the needle failed to reach the ganglion, and only one cause can be ascribed, *viz*, some slight variation in the bony contour of the skull Whether successful or not, the passage of the needle in these instances inflicted no serious damage to the patient The orbital portion of the route was entirely painless, the passage behind the orbit intensely painful In two of the cases it was demonstrated by suction on the needle during its entrance that the cavernous sinus was transfixed, in two cases no effort was made to determine whether or not the sinus was injured, and in one it was self-evident that the needle had terminated within the sinus Yet in no instance were there symptoms to indicate intracranial or retrobulbar hemorrhage The subcutaneous ecchymosis that followed the puncture in three cases was of no greater extent than could be attributed to any such traumatism to these tissues, and the orbital œdema in Case V was very probably induced by a few drops of alcohol left in the orbit by the retiring needle, a complication preventable by negative pressure exerted upon the needle during its withdrawal In three cases when the bony terminus was reached and the stylet removed, cerebrospinal fluid flowed from the needle, venous blood exuded in one case, and in one the puncture was dry

To strike cerebrospinal fluid at the end of the passage indicates that the cave of Meckel is reached and that injection of solution will involve the ganglion root, to strike blood indicates clearly that the needle has stopped within the cavernous sinus and that further attempt to reach the ganglion should be abandoned, to obtain a dry puncture means that the needle has entered the lower part of the ganglion below Meckel's cave, and an injection of solution will flow upwards into the cave and thereby infiltrate the nerve root, or that the needle missed its mark and has come to lodge in some non-vascular tissue An easily executed passage is no certain indication of a successful puncture, nor is complaint on the part of the patient of pain in the trigeminal distribution A needle terminating near to the nerve may press upon it and

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lead to the conclusion that the structure has been entered Trial injection of novocain is the most accurate determining factor

The purpose of the procedure in Cases I, II and III was temporary ganglion block anæsthesia In Case I, 5 per cent cocain solution was used and satisfactory anæsthesia obtained during the entire operation This drug, however, was probably responsible for the subsequent vomiting and its use has been given up In the second, 4 per cent novocain solution was employed, 3.5 c c in two injections The anæsthesia was complete but began to disappear in from fifteen to twenty minutes after the first injection In the third case 2 per cent novocain was used Its effects were adequate but very transient, and frequent reinjections were necessary, the total amount of solution used being 20 c c There is little doubt that this novocain solution, far too great in amount to be accommodated by Meckel's cave, flowed back into the basilar cistern at the base of the brain, and yet there was not the slightest sign of its action upon the nerve structures of this region Evidently the gradual introduction of comparatively large quantities (up to 20 c c) of 2 per cent novocain produces no ill effects, still it is a needless and troublesome performance The higher concentration of novocain (4 per cent) should be employed

In Case V, the purpose of the puncture was permanent anæsthetization of the trigeminal nerve for the treatment of tic douloureux The needle reached the ganglion, and 2.5 c c of absolute alcohol were injected in three portions over a period of twenty minutes The symptoms which followed this treatment give a clue to the behavior of the injected alcohol Because the needle was stopped at a proper depth and gave vent freely to cerebrospinal fluid, and because trial novocain injection produced complete trigeminal anæsthesia, it may be concluded that the needle point had terminated in the perineural space of Meckel's cave

We have found in our experience with the injection of stain in cadavers, that fluid placed in Meckel's cave, be it more than a few drops in amount, will discharge posteriorly into the basilar cistern The cave is apparently in free communication with the subarachnoid spaces at the base of the brain Alcohol injected in this Case V probably took the same course, and as it entered the cistern was caught in the cerebrospinal stream and dispersed among the cranial nerves which cross the cistern in their passage from the brain stem As evidence we have the ophthalmoplegia and facial paralysis following the injection It is to be surmised that the alcohol, already somewhat diluted by mixture in the cave, became further diluted in the fluid of the cistern before it attacked the neighboring nerves This explains the transiency of the paralysis of the third, fourth, sixth and seventh nerves

CONCLUSION

It is evident that whatever injury is inflicted upon the root of the ganglion by the injection of alcohol will be shared to a less extent by neighboring nerves This is true, no matter by what approach or technic the needle

is entered, and trans-orbital puncture is no exception. Accordingly, until some means shall have been discovered of preventing this widespread diffusion of the alcohol, we cannot at all recommend the puncture in the therapy of trigeminal neuralgia.

Other possibilities for the employment of the technic suggest themselves. It affords a method of withdrawing cerebrospinal fluid directly from the basilar cistern. Wider experience may justify an attempt to use this route for therapeutic applications to the central nervous system. The effect of air injections in the X-ray diagnosis of intracranial disorders is likewise worthy of investigation.

But in the meanwhile the results of this work, both anatomical and clinical, lead us to believe that transorbital puncture of the Gasserian ganglion furnishes a relatively simple means of securing block anaesthesia for operations in the territory supplied by the trigeminus, fully justified in cases where general anaesthesia is contraindicated.

I wish to acknowledge my obligation to Professors Ferris, Burr and Flint for their direction in the investigation of this technic from an anatomical and surgical standpoint, and to Professor Verdi, from whose private practice Cases I, II, IV and V are taken, and to whose encouragement a great deal is owed in the success of these first applications of the technic in the clinic.

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A STUDY OF METHODS OF PROCEDURE IN RESECTION OF THE ŒSOPHAGUS

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THE surgery of the œsophagus for many years has taxed the ingenuity of surgeons all over the world, and although much experimental work has been done since 1871 when Billroth reported the first successful resection, to-day the œsophagus is almost *noli me tangere*, and resection is an operation fraught with many dangers and attempted only in the most desperate cases

Experimental work and cases have been reported by Billroth, Garré, Van Hacker,⁵ Czerny, Stieda, Mallener and others in Germany, Lapeyre and Vulliet in France, and Lihenthal, Myer,⁶ Janeway and Green⁷ in America, but with all these observers no uniformly successful method of resection has been obtained, although important strides have been made as the result of their efforts

The surgery of the œsophagus is difficult first from the standpoint of locality, second because of its structure. In its cervical portion it is easily mobilized, but in its thoracic portion it lies deep in the mediastinum in juxtaposition to such delicate and important structures as the pericardium, trachea, pleura, vagi, left recurrent laryngeal and sympathetic nerves, thoracic duct, aorta and left subclavian artery and azygos vein. Mobilization is therefore extremely difficult. From the standpoint of microscopic anatomy, it is seen that there is no definite coat sufficiently strong to hold the sutures in place, such as the submucous layer in the intestine, the importance of which Doctor Halsted has demonstrated in intestinal suture. This makes it difficult to procure a line of suture which will withstand tension, and since the œsophagus is fixed at its upper and lower end, each descent of the diaphragm with inspiration causes a strain to be put on the line of union and makes leakage more probable.

Other facts which add to the difficulty and danger of œsophageal resection are (a) the inability to stretch the œsophagus and thus approximate the two ends after excision of a portion, (b) the absence of a serous coat which results in the failure of adhesions, which would prevent leakage, to form around the line of union, (c) the low resistance of the loose connective tissue of the mediastinum to infection, and (d) the constant presence of bacteria in the œsophageal lumen.

The first successful report of resection was made by Billroth¹ in 1871. He excised a segment of the cervical portion of the œsophagus, making a fistula in the neck, through which bougies were passed to prevent stricture and through which the patient was fed.

Czerny, in 1895, reported a case in which he resected 4 cm of the œsophagus 17 cm below the teeth. Approximation of the ends was not possible,

so he put in four fixation sutures and inserted a tube from the mouth through the upper segment and down into the lower segment. The wound was closed and the tube remained in four days. The patient recovered. Garré³ reported a similar case in 1898, and a year later another case which he did in two stages. First, he did a gastrostomy to improve the general condition of the patient, and in a second operation he resected 9 cm. of the œsophagus for carcinoma 16 cm. below the incisor teeth. He buried the lower end of the upper segment in the wall of the thorax, closed the upper end of the lower segment, and fed the patient through the gastrostomy opening. The patient was well at the end of one year. In the same year Sandelin reported a case in which he closed the œsophagus layer to layer after resecting a stricture in the cervical portion. He inserted a tube to protect the sutures past the line of anastomosis and the patient recovered. Similar successful cases have been reported by Narath and Braun, in which the ends of the œsophagus after resection were closed layer to layer and a tube inserted to protect the sutures.

It is therefore seen that up until comparatively recently resection of the œsophagus has been attempted, at least in humans, only in its cervical portion. With the advance of the surgery of the thorax and the introduction of various positive pressure apparatuses, surgeons have been able to attack the problems of œsophago-gastrostomy and resection of the thoracic œsophagus. It was soon realized that, because of the numerous difficulties mentioned at the beginning of this article, a plastic operation was the procedure of choice in cases of resection. This led Bircher,⁴ in 1894, to attempt the construction of a skin tube which was united to the œsophagus in the neck and to the stomach at a gastrostomy opening. The patient died of pulmonary embolism shortly after operation.

Wullstein,⁸ in 1904, realizing the difficulty of anastomosing the stomach and the skin tube because the acid gastric juice may cause the line of anastomosis to break down, advised shunting off the stomach and duodenum and connecting the skin tube to the jejunum. This method met with no success, but in 1907 Roux isolated a loop of jejunum, drew it up as far as the sternal notch by tunneling under the skin of the thorax, and anastomosed it with the cervical œsophagus above, and the stomach below. This was tried in several cases, in all of which the isolated jejunal loop became gangrenous as a result of disturbance in its blood supply. This led Herzen,⁹ in 1908, to bring the jejunum through a slit in the transverse mesocolon and gastrocolic ligament in order to avoid twisting the mesentery which causes constriction of its vessels and results in necrosis of the jejunum. The patient recovered. These observations caused Lexer,¹¹ in 1911, in a case of carcinoma of the œsophagus to do a combination of the Roux and Wullstein methods. At the first operation he performed a Y-shaped anastomosis of the stomach and jejunum. At a second operation he created a skin tube, did an œsophagostomy and united the skin tube with the upper end of the œsophagus and the jejunum. The patient recovered.

Stieda,¹⁰ 1913, in a case of impermeable stricture following erosion of the œsophagus due to swallowing H_2SO_4 , carried out the following procedure with success. First operation—gastrostomy. Six months later he constructed a skin tube by making two incisions 3 cm apart, parallel to the sternum and slightly to the left of the midline. These began at the level of the left clavicle and extended to the xiphoid. The edges of this strip were then dissected up just a little and then sewed together, forming a tube. There resulted, of course, an area, where the skin flaps had been taken, not covered by skin. This was remedied by mobilizing the outer edges of the defect and sewing them together over the skin tube, thus covering the defect and the tube with skin. The lumen of this skin tube was maintained by the daily passage of bougies. This method of instrumentation is preferable to the insertion of an indwelling rubber tube, which was done in one case, and resulted in pressure necrosis of the skin tube. One year later he made an œsophagus fistula, and five months following this he united the skin tube to the stomach and œsophagus. The union of the œsophagus fistula to skin tube was made by taking a skin flap from the left side of the neck, cutting toward the midline in such a manner that the sides of the skin could be sutured to the skin tube and œsophagus respectively. He then skin-grafted the defect in the neck. Three weeks later the patient could swallow foods without difficulty and was discharged from the hospital in excellent condition.

Another method attempted at about this time by Hirsch,¹⁰ Jianu¹⁴ and Roepke¹⁵ was the use of the stomach wall in the formation of a tube, which was then pulled up under the skin of the thorax. Hirsch, using cadavers and dogs, made a tube by isolating a longitudinal section from the anterior wall of the stomach, sewing the edges together, at the same time closing the defect in the stomach. This was unsatisfactory because the tube could not be made sufficiently long and the stomach was left too small following the removal of such a large portion of its wall. Jianu then advocated isolating a segment along the greater curvature of the stomach and Roepke did this successfully in one case which he reports. His method of procedure, as described by Myer, was as follows. A midline incision was made from the xiphoid to the umbilicus. The greater omentum was tied off and divided close to the stomach as far as the point where the left gastro-epiploic artery turns on the stomach. The right inferior gastro-epiploic artery was divided two inches from the pylorus. Mattress sutures through the entire thickness of both walls of the stomach were placed $1\frac{1}{2}$ inches distant from and parallel to the greater curvature of the stomach. An intestinal clamp was placed along the suture line or immediately above it, and the stomach divided between the clamp and the layer of mattress sutures. The mattress sutures were then tied and a continuous suture was begun at the duodenal end of the cut and continued out to the end of the isolated portion of the greater curvature, thus converting it into a tube 25 cm long, which was brought out of the abdominal incision and could be drawn up under the skin of the thorax as far as the cartilage of the third rib. The end of the tube was then opened and fastened

to the skin wound Myer¹⁷ points out that since the vessels of the tube run in a horizontal direction, fascia necrosis will occur if they are constricted by sutures through the seromuscular coat Therefore, it is important to engage only the submucosa in the stitch where the tube is anchored to the skin wound This may be done stripping back the seromuscular coat Myer also shows that in drawing the tube up under the skin, it is better to have it run subcutaneously than submuscularly, because if infection should occur, it could be combated more readily

At a second operation thoracotomy was done and a skin tube made to connect the subcutaneous stomach tube and the oral end of the œsophagus It is obvious that if the oral end of the œsophagus is long enough to reach the stomach tube, no skin plastic need be done, and also if the resection is between the aortic arch and the cardia, the stomach tube can be brought up intrathoracically and united to the œsophagus

Von Hacker¹⁸ reports a case of resection of a stricture in a thirteen-year-old girl, in which he brought the transverse colon instead of the jejunum up under the skin, and got a perfect result The child has no difficulty swallowing and eats almost any solid food There is, however, no apparent advantage in using the transverse colon instead of the jejunum if care is taken to avoid twisting the mesentery of the jejunum, thus causing constriction of its vessels

In another case he used the jejunum in a similar manner, but only a very short loop He made a skin tube extending from the clavicle to the gastrotomy opening and used only a very short loop of jejunum to interpose between the stomach and skin tube in order to prevent the formation of a fistula, which has been shown by Blauel²¹ to occur almost invariably if anastomosis of skin tube and stomach is attempted, due to the action of the gastric juice This case also had a complete recovery He (Blauel) reports three cases, one of which died of empyema, one developed a fistula at the junction of the skin tube and intestine, and one got well

One of the most brilliant successes is in a case reported recently by Madlener,²⁴ who advises that œsophagostomy and the formation of the skin tube be done in one sitting except when the freeing of the œsophagus is difficult, and this is rarely the case In his case an incision was first made parallel to and at the level of the lower edge of the left clavicle, a little to the left of the midline The advantage of this incision was that through it the œsophagus below the first tracheal ring and in the upper part of the mediastinum could be exposed, and because the lower skin edge of the incision is transverse, it could be used as the upper end of the skin tube Then two parallel incisions were made, beginning at each end of the first transverse incision, a rectangular piece of skin isolated, and a tube made by sewing the two lateral edges together The œsophagus was then isolated, divided transversely, and the oral end brought to the surface Madlener says the transverse division is preferable because there is a better possibility of healing between it and the skin tube than there is when it is incised longitudinally, as

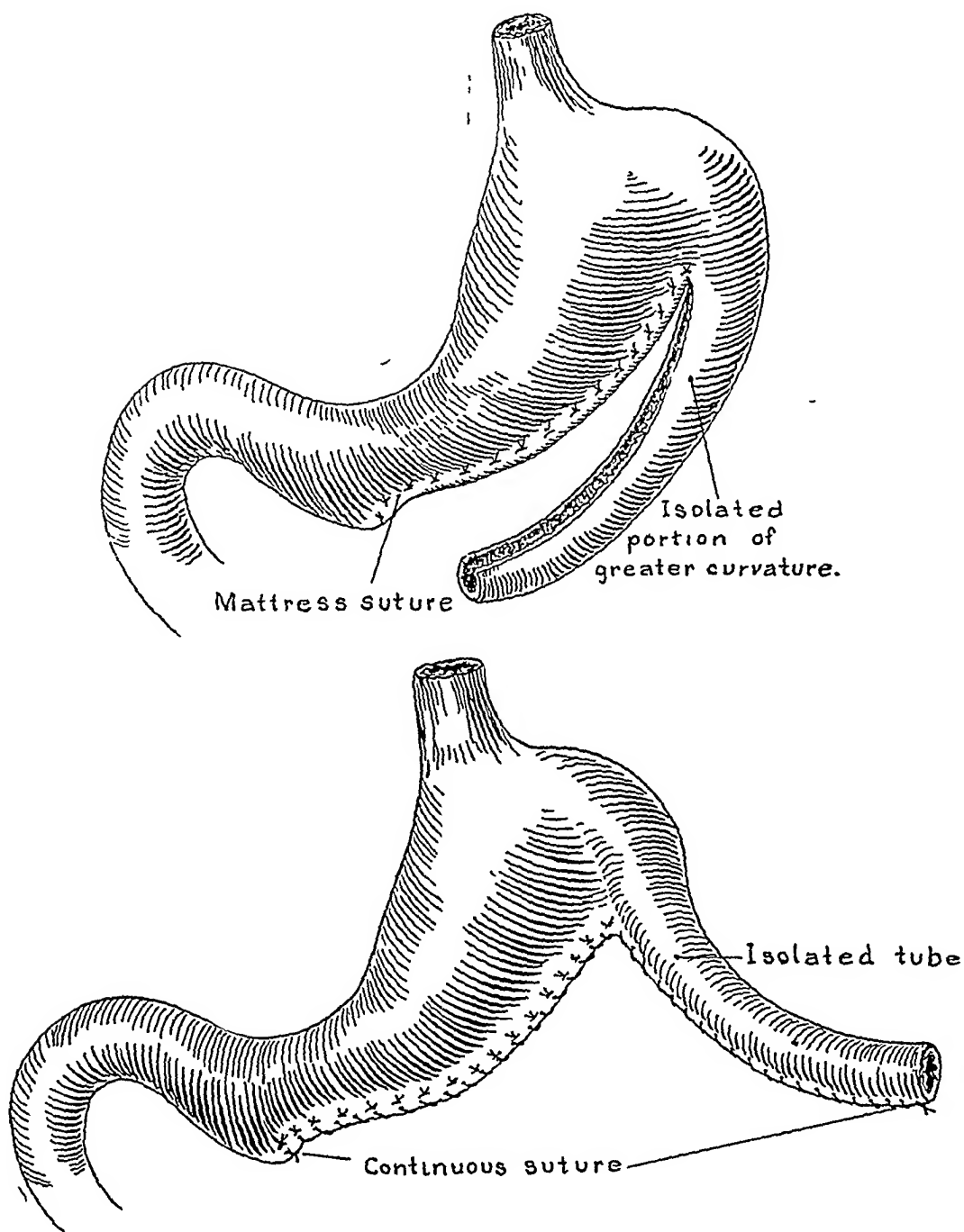


FIG 1 —Jianu Rőepke method of making tube from the stomach

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has been the custom formerly The skin tube and oral end of the œsophagus were then united and a gastrostomy done

The defect which was the result of the skin tube formation was corrected by making two lateral incisions 10 cm long in the infra- and supraclavicular fossa, the skin mobilized and brought over the skin tube, thus covering the first defect but leaving two defects in the clavicular fossæ These, however, were readily covered over by Thiersch grafts The object of these two lateral cuts is that it allows the skin edges to be closed over the skin tube without tension and minimizes the possibility of breaking down of the wound Two weeks later the patient was released, but daily bougies 12 mm in diameter were passed to prevent occlusion or stricture of the tube One month after the first operation the patient reentered the hospital During this time he had fed himself through the gastrostomy wound The wounds of the previous operations had practically healed

Second Operation Provisional Closing of the Gastric Fistula—The jejunum is cut across 10–12 cm below the duodeno-jejunal junction, the oral end clamped and filled with gauze The mesentery of the aboral end was ligated and divided close to the root of its vessels so that 17 to 18 cm of jejunum was freed, leaving enough for adequate blood supply to the isolated loop This loop was brought through an incision in the gastrocolic ligament and the transverse mesocolon up to the surface, being careful to avoid twisting of the mesentery At this point, by means of an incision through the skin of the thorax, a subcutaneous skin tunnel was made through which the freed end of the jejunum was brought This tunnel is about 5 cm long The skin tube and jejunum were then united by means of skin flaps

Now follows the lateral anastomosis of the oral end of the divided jejunum with the most convenient point in the distal segment Thus, there is a Y-shaped anastomosis of the jejunum with the open end extending out of the abdomen The jejunum is then divided just above the place where the lateral anastomosis was done and the aboral end of the isolated loop anastomosed with the stomach Healing occurred without reaction and the union of the skin tube and jejunum was per primam

Two weeks after second operation the entire wound had healed and an 11-mm bougie could be inserted easily into the stomach from the mouth This was done frequently, as stricture is very liable to occur at the junction of the skin tube and œsophagus or skin tube and intestine

Madlener reports that three and a half months after the beginning of the œsophagus-plastic the patient could eat solid food, without even drinking water afterwards, and when he swallows, one can see the distention of the skin tube and peristalsis of the intestinal tube, and that no difficulty is experienced getting food into the stomach, as the force exerted by the muscles of deglutition is sufficient to give the food momentum enough to reach the intestinal tube

With the X-ray it was demonstrated that the boy could eat 510 cc

barium mush in two minutes First plate in fifteen seconds, second in two minutes

The lower end of the intestinal tube was seen lying horizontally at the

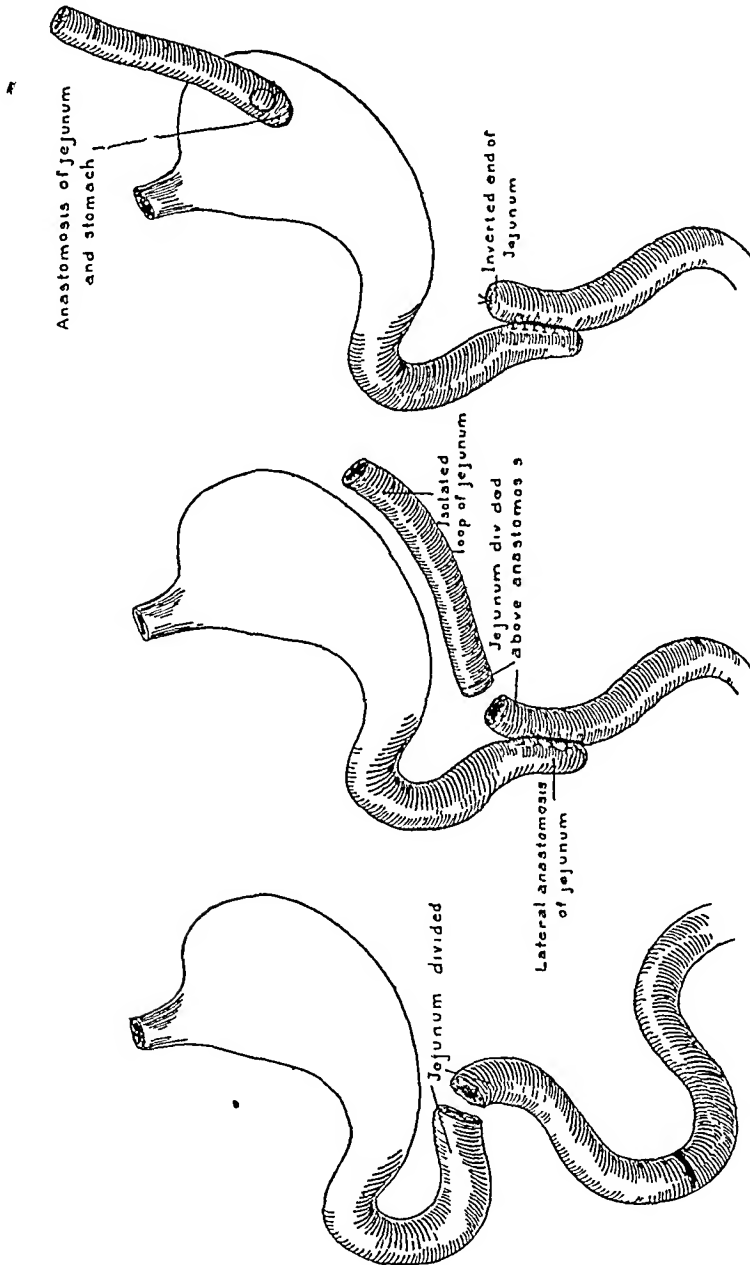


FIG 2 —Securing a loop from the jejunum to supply the place of the excised portion of the esophagus

lesser curvature of the stomach The only discomfort experienced by the patient was gaseous eructations which occur after meals

Analysis of the results of the foregoing cases shows that the procedure of choice in cases of stricture and carcinoma depends on several factors The first and most important consideration is the location of the lesion,

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and secondly, the amount to be resected. If the lesion is located in the cervical region, and only 1 or 2 cm of the œsophagus is to be resected, *e g*, for stricture, it is possible to anastomose the ends. When this is done Lapèyre¹⁰ has demonstrated on dogs that it is essential to place the sutures in such a manner that they lie perpendicular to the longitudinal muscle fibres, otherwise, they will pull out and result in leakage. His method is illustrated in the accompanying illustration. Following the operation, bougies should be passed daily to prevent stricture at the point of anastomosis.

If, however, approximation of the ends is impossible after resection, one of several procedures may be chosen. First, both ends of the œsophagus may be closed after resection, and the patient nourished through a gastrostomy opening. Secondly, an œsophageal fistula may be made by bringing

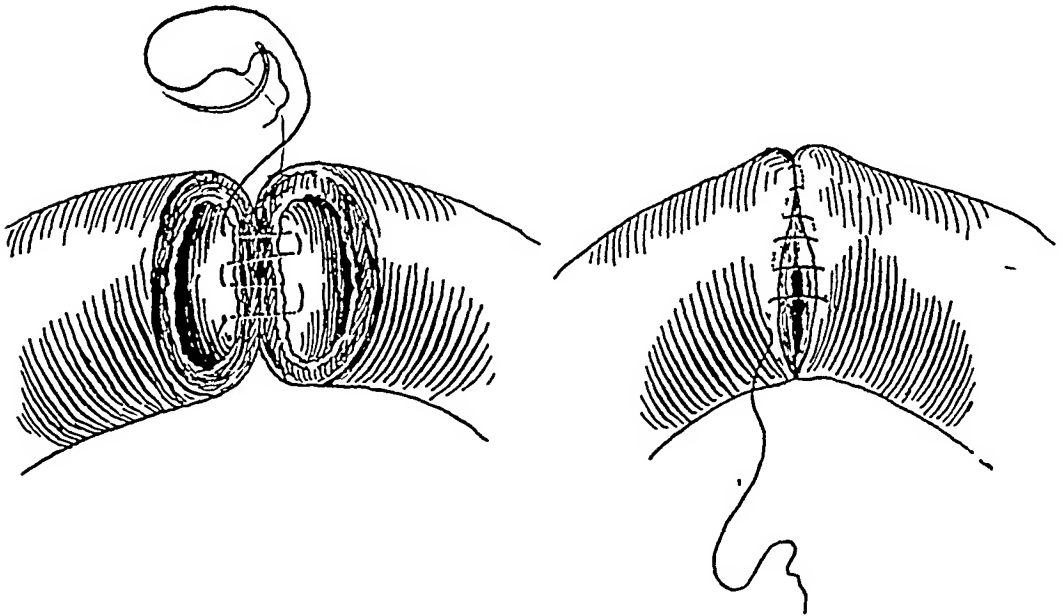


FIG 3 —Shows sutures placed perpendicular to the external longitudinal muscle layer

the aboral end out and suturing it to the skin. Thirdly, by means of a skin flap a tube may be made to supply the defect. The first of these three methods is the least desirable from the standpoint of the functional result, but is the simplest. The second gives a slightly better functional result and makes the patient more comfortable, but there is more danger of peri-œsophageal infection, due to leakage around the wound. The third method gives the best end result of all, if it is successful, because the patient is able to chew his food and swallow it. If the lesion is in the thorax, a plastic operation is the procedure of choice, except when the portion to be resected is at the cardia and it is possible to do an œsophagogastrostomy and supply the defect by the formation of a tube made from the greater curvature of the stomach by the Jianu-Roepke method described above.

When the plastic operation is to be done, it should be performed in several stages, the procedure at each stage being more or less arbitrary. One may do as Madlener did, *i e*

First operation (1) Formation of skin tube, (2) œsophageal fistula in the neck with its union to the upper end of the skin tube, (3) gastrostomy

Second operation (1) Y-anastomosis of jejunum, (2) union of lower end of skin tube and isolated jejunal loop, anastomosis of jejunal loop and stomach

Or, which might be more advisable, one may at the first operation isolate a loop of jejunum by a Y-shaped anastomosis, bring it out through the abdominal wound and draw it up under the skin of the thorax a short distance, suturing it there. Then anastomose the oral end of the freed loop of jejunum and the stomach by closing the end of the jejunum with a purse-string suture, and uniting the jejunal loop and the stomach as in a gastroenterostomy. The advantage of doing this is that it completes the abdominal work except for the

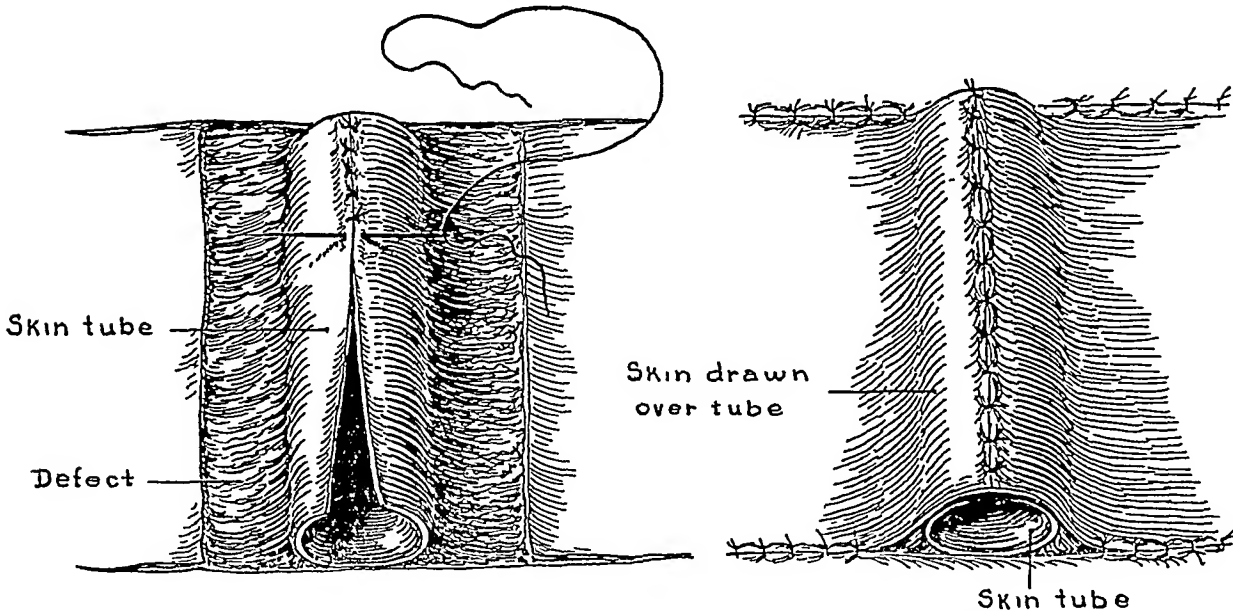


FIG 4—Constructing a skin tube to connect œsophagus and jejunal segments

subsequent closure of the gastrostomy opening. Another advantage of this is that by doing a gastrostomy at the first operation, the patient can be nourished through it and be made better able to withstand the subsequent operations. This is often of importance as the patients are frequently in a very undernourished condition as the result of the œsophageal obstruction.

At a second operation the skin tube is constructed, an œsophageal fistula made and the skin tube united to the œsophagus above and the jejunal opening below. The construction of the skin tube is as follows:

Two parallel incisions are made about 8 cm. apart, beginning at the level of the clavicle and extending to the point where the jejunum opens on the surface. These incisions are a little to the left of the midline and are joined to each other by incisions between their upper and lower ends. The lateral edge of the inner incision and the medial edge of the lateral incision are then dissected up and sewed together to form a tube. To cover the resulting defect,

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the other two edges are drawn over the tube, the result being that the skin tube is subcutaneously placed

Following this, bougies should be passed daily to prevent stricture until the wounds have healed and the newly-made tract can be used. Then a thoracotomy is done, the lesion resected, closing the cut ends of the œsophagus by inverting them with purse-string sutures. At the same time, the gastrotomy opening may or may not be closed, depending on whether the new tract for the passage of food is healed completely.

The following table is an analysis of twenty-five cases reported since 1871

Name	Date		Resected	Loca- tion	Result	Remarks
Billroth	1871		0	c	w	Cervical fistula made
Czerny	1877	car	?	c	w	Case followed five months
Von Bergman	1883	car	6.5 cm	c	d	Mediastinitis, pericarditis, pleurisy, pneumonia
Novaro	1883	str	3.7 cm	c	w	Seen in seven weeks after operation
Braun	1891	str	1-2 cm	c	w	
Bircher	1894	car	0	t	d	Attempted skin tube formation. Patient died at operation
Czerny	1895	car	4 cm	c	w	
Rehn	1897	str	0	c	d	Cervical fistula
Rehn	1897	car	0	t	d	Operation not completed
Garre	1897	car	Larynx	c	w	Skin plastic in neck
Garre	1898	car	9 cm	c	w	Case followed one year
Sandelin	1899	str	?	c	w	
Schalita	1902	car	5 cm	c	w	Cervical fistula
Wullstein	1904	car	0	t	w	Skin plastic plus jejunal loop
Gluck	1905	str	0	t	w	Skin-tube method
Bircher	1907	car	0	t	d	Attempted skin tube. Patient died before completion
Roux	1907	car	0	t	d	Gangrene jejunal loop
Herzen	1908	str	0	c	d	Gangrene jejunal loop
Fragenheim	1910	str	0	t	w	Skin plastic plus jejunal loop
Lever	1911	str	0	t	w	Modified Roux
Myer	1912	str	0	c	w	Jianu-Roepke method
Stieda	1913	str	0	t	w	Skin plastic
Von Hacker	1919	str	0	c	w	Skin plastic. Case followed four years
Nicolaysen	1919	str	0	t	w	Jianu-Roepke method
Madlener	1920	str	0	t	w	Skin plastic

Analysis of the above twenty-five cases collected from the literature shows fourteen cases with the lesion in the cervical region and eleven in the thorax. Of the fourteen cases in the neck, resection was carried out and in six with one death.

Among the eleven cases with the lesion in the thorax, there are four deaths reported, but it is significant in the last five cases (Madlener, Nocolay-sen,²³ Lexer, Fragenheim¹²) there is no mortality, the four deaths occurring in the first six cases, two of these being operated on over fifteen years ago. In these last four cases the skin tube was used in all except one, in which the Jianu-Roepke method was employed. In none of these cases, however, is any attempt made to resect the œsophagus.

This, of course, is not necessary if the operation is done for stricture, but in case of carcinoma it would be necessary to resect a portion if a cure is to be hoped for.

According to these statistics therefore the skin-tube method is one which has been done with excellent results in the last ten years and should be the method employed in case of carcinoma and stricture of the œsophagus, when cure by dilatation with bougies is not possible.

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OBSERVATIONS UPON THE SURGERY OF THE LUNG

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IN looking over the literature of the surgery of the lung since the publication of my first paper on Empyema in the ANNALS OF SURGERY, 1907, 45, 373, I have been impressed with the fact that some of the principles I then advanced and which I hoped would be generally accepted and utilized, have been ignored or overlooked by many medical men. It is in the hope that surgeons generally will give these facts further consideration, and by applying them prove their efficacy and their limitations, that I am presenting this paper. The great deterrent to operative work on the lung has been the fear on the part of the internist as well as the surgeon, of the pneumothorax and the collapse of the lung. To this must be added mediastinal flutter. It was this fear that led to the use of the negative and positive pressure apparatus to enable the operator to maintain the lung in expansion during the progress of his operative manipulations.

The first question then is: How dangerous is pneumothorax *per se*?

Artificial pneumothorax has now been practiced for a number of years with the definite purpose of collapsing the lung and putting it either temporarily or permanently out of business. The unsatisfactory results of this procedure have been due to the simple reason that it does not set up an inflammatory pleuritis and consequently does not provide against a re-expansion of the lung by causing adhesions between the collapsed lung and the chest wall, so that as the gas is absorbed the lung again expands and the relief is found to be only transitory. If when these injections into the closed pleural cavity are made we could only devise some method of exciting adhesions between the pleuræ of the collapsed lung and the parietes, we should attain our object and secure the permanent removal of the lung from its usual functional activity, and obtain the rest necessary for the cure of the tuberculous focus.

The failure of this method to offer a permanent compression of the lung has led to the operation of removing the chest wall down to the pleura and filling the cavity with a portion of the scapula, fat, depressed skin flap, or a transplant of the pectorales major and minor. This is nothing more than a modified Estlander's operation, and has as yet not been performed often enough nor have the cases been watched long enough to give definite information of its efficacy.

In our operative work, we have the same result when pneumothorax occurs, provided the operation is sterile, as we have when we inject gas into the pleural cavity. The air is gradually absorbed, the lung expands, and resumes its normal functional activity. After sterile stab or gunshot wounds which have been hermetically sealed, the same result obtains, provided there is no effusion of serum or of blood, and the patient makes an uninterrupted and complete recovery.

A very different picture presents itself if the pneumothorax is caused by an escape of air from an opening in the lung itself into the closed pleural cavity. Here we have a constantly increasing pressure of air in the closed space with a consequent compression of the lung, the displacement of the mediastinum and the heart to the opposite side, causing marked circulatory and respiratory symptoms. In these cases the indications are clear. An incision in the chest wall should be made immediately, and if no other complications are present, particularly hemorrhage, the insertion of a tube of just sufficient calibre to allow the escape of the air, will at once relieve the pressure, enable the injured lung to expand, and in all probability the pulmonary wound will close of itself without further operative interference. As soon as the pulmonary wound has closed the drainage tube may be withdrawn.

At the present time, extra-pleural thoracoplasty is employed most frequently of all the open operations for bronchiectasis and pulmonary tuberculosis. This method has the advantage over the compression of the lungs by gas injections into the closed pleural cavity of producing a permanent compression of the lung. It has the disadvantage of an increased mortality, as well as the putting of the lung out of function permanently. Some surgeons feel that this operation should be reserved for the tuberculous cases only, while the bronchiectases should be treated by incision and drainage or by lobectomy. It is more than probable that with increased experience the tendency of the thoracic surgeon will be to adopt the latter method, because this permits the remaining portion of the lung to resume its normal function, an important consideration in all cases. Judgment and experience will have to determine the procedure in each individual case. So far as I have been able to determine by studying the literature and examining some of the cases which have been subjected to the operation of extra-pleural compression for bronchiectases, while they may show improvement, and the amount of expectoration may be diminished, they are not cured and are liable to a return of their symptoms from time to time.

This operation may be performed under local anæsthesia by a series of nerve blockings on the twelve thoracic nerves of the affected side. The best place to make the puncture is over the articulation of the rib, with the transverse process of the vertebra, deflecting the needle as soon as it comes in contact with the bone—first, to the space above the rib line, and second, to that below. Eight to ten cubic centimetres of novocain thrown into each of these spaces ordinarily suffices to produce a complete nerve blocking, making it possible to resect a considerable portion of the chest wall without discomfort to the patient. At least fifteen, and preferably twenty minutes from the injection of the anæsthetic should be allowed to elapse before the operation is begun. This is definitely the point of selection when we remember that “at first each intercostal nerve lies near the head of the rib below the intercostal artery and directly covered by the costal pleura and the endothoracic fascia.” We must also remember that the twelfth nerve comes through the

intervertebral foramen between the twelfth dorsal and first lumbar vertebra

One must determine at the time of the operation whether the patient's condition will allow of a complete excision of all of the ribs and a compression of the whole lung, or whether for safety's sake the operation must be performed in stages. If a complete operation cannot be performed, it is generally considered preferable to take the lower ribs first, so as to compress the lower lobe, in order to avoid the possibility of the drainage from the cavities being drawn down into the more dependent portions of the lung and producing serious symptoms. In the cases of large cavities, the operation under local anæsthesia has the distinct advantage that the patient, being conscious, is able to cough and expectorate any secretion that may be pressed out of the cavities during the operative procedure. In case the patient is able to stand the complete operation at a single sitting, the Schede operation is the better, and the incision for the operation gives by far the best approach to the chest wall.

It has been claimed that sixty-six per cent of cases operated upon for tuberculous cavities by this method in the hands of foreign surgeons have been successful. While I am not confident that these statistics have been sufficiently well collated to be of great practical value, I am convinced that the position that I took more than twenty years ago is correct and that cases of single tuberculous cavities in one lung will be benefited if operated upon.

Our experience during the war demonstrated rather forcibly the fact that pneumothorax caused by a wound in the chest wall was not a condition to be dreaded by the surgeon. I think the great majority of us who had the opportunity of seeing these cases on the other side will remember numerous incidents where patients were brought into the hospital even with large mutilating wounds that produced little or no disturbance of respiration or circulation. It is true, the lung on the injured side was collapsed, but how frequently was it possible for us, when the symptoms were caused by a machine-gun bullet and the wound was sterile, to close these wounds and see the patient progress to a complete recovery.

Many surgeons have recognized the fact that there was no immediate danger from the pneumothorax when operating on the pleural cavity. It seems strange that physicians generally should have such a dread of pneumothorax as they do. In the surgical history of the Civil War, 11, 540, chest wounds were recorded, and yet complications due to the pneumothorax were recorded in less than half a dozen. John B. Murphy, in an address on "Surgery of the Lung," delivered at the Forty-ninth Annual Meeting of the American Medical Association, held at Denver, Colorado, in 1898, said "That there is little shock or discomfort produced by the admission of air into the pleural cavity, has been shown by numerous accidents to the chest, experiments and operations, extending from the time of Hippocrates to the present day." With all of our experience in experimental, operative and accidental opening of the pleural cavity we should have overcome the dread of pneumothorax by this time, and yet we find that this dread is the greatest

deterrent to the reference of lung cases to the surgeon for operation

Many years ago while experimenting on animals, I was able to demonstrate this conclusively, and since that time I have never hesitated to open the chest cavity freely in order to perform any necessary surgical operation. The recognition of this fact has enabled me on several occasions to remove cancers of the breast which were attached to the ribs and even invaded the pleura—in several instances removing the whole of the anterior portion of four ribs, including the chest wall and pleura, and closing the wound by a large pediculated abdominal flap, in one instance I not only removed four ribs with the parietal pleura, but also two cancerous nodules in the lower lobe of the lung, doing a partial lobectomy. Two weeks later I removed the supra-clavicular glands in this same patient, and she lived for two years after the operation. This operation was done some years ago.

The question of mediastinal flutter must be considered in this connection. Murphy recognized this, and it seems to me that it is wise in this connection to quote rather freely from what he said. "The most pronounced and dangerous manifestation observed in my experiments was when a medium-sized opening (two inches in length) was made in an intercostal space and the air allowed to pass in and out with some opposition. The lung on the open side gradually contracted to the hilum, the mediastinal septum and contents flapped to and fro in respiration, like a sail during a lull, when the dog inhaled, the mediastinal septum concaved greatly to the uninjured side, when he exhaled, it convexed to the opposite side. The chest ceased to be a cylinder for the piston—the diaphragm in the respiratory act. The mediastinal septum became a second diaphragm which contracted and destroyed the aspirating or piston power of the true diaphragm. With this motion of the septum, there was comparatively no exchange of air in the lung, there was merely a variation in the shape of the lungs, the septum soon became emphysematous and ruptured. The dogs in this experiment had rapid, panting respiration, which shortly ceased. The respiration could be easily restored by placing the hand over the opening in the chest wall with the diaphragm, either concave or convex. By keeping the hand in position for a few minutes, the cyanosis would disappear and the animal reacted to his normal condition, proving that it was not the displacement of the mediastinal organs to right or left, not the diminution in the respiratory area, but the absence of secure pressure which forced the air out of the lung on the healthy side in expiration and aspirated it in inspiration.

"I am convinced that the dyspnoea following opening of the pleural cavity is due to the vibration of the mediastinal septum and contents, destroying the piston action of the diaphragm. In support of this theory, I wish to call attention to the methods of relief reported by different operators in cases of dyspnoea following opening of the pleura in surgical operations on the lung or pleura. The operators closed the opening regardless of the condition of the lung, as far as contraction and expansion were concerned, still the patients were relieved. Delageniere filled a pleural cavity with

water to prevent dyspnoea after he had resected the rib and removed a very large quantity of pus from the cavity. It can be seen from this case that the respiratory area was not increased, the quantity of blood in or out of the lung was not changed, and the pneumogastric filaments were not interfered with, but the chest cylinder was rendered complete by the immobilization of the mediastinal septum. Covering the opening in the chest with gutta percha to prevent the intake and egress of air would have accomplished the same result. When a drainage tube has been inserted into the pleura and dyspnoea occurs, the occlusion of the tube relieves it. I found that by placing a forceps on the collapsed lung and drawing it into the opening the dyspnoea was immediately relieved and respiratory movements were at once resumed. Forceps placed on the hilum of the lung, immobilizing the septum, had the same effect. I also noted that if the lobe were secured in the aperture and only partially filled it, it did not take part in the respiration, but the dog was relieved, due, I believe, to the steadying of the mediastinal septum. The plugging of the trap-door orifice with the lobe, or suturing it to the margin, was the best method for the relief of the dyspnoea. Carl Bayer, when operating in a case, drew up the collapsed lung and sutured it to the margin of the wound, the symptoms of dyspnoea and collapse disappeared and this portion of the lung filled and emptied in respiration."

Some operators, in doing lobectomy, have left a long suture attached to the stump, coming out through the wound in the chest wall, so that in case of the mediastinal flutter traction on the diseased lung could be made and the condition relieved. Undoubtedly in this condition there is a lack of proper filling of the healthy lung on its side of the mediastinum. If the anæsthetist at the time of the operation is provided with an intratracheal catheter which can be quickly inserted into the trachea and attached to a rubber bulb, the collapse of the lung can be quickly overcome by pumping in air, expanding the lung until it provides sufficient pressure against the mediastinum to overcome this condition.

The great majority of the operations on the lung can be done without excision of the ribs. Lilienthal and Tuffier have both improvised rib dilators in order to increase the space between the ribs during the operative manipulations. In these cases a single incision, running around the chest wall, separating the intercostal muscles at about the seventh or eighth rib, and extending from the costal margin to the vertebral articulation, will usually give an abundance of room, and provide against the retraction of the chest which necessarily results from a rib resection. Through this incision, it is possible to close an open bronchus, to arrest a hemorrhage, or even to perform a lobectomy. In case a rib dilator is not available, I have found that it was possible to dilate the ribs sufficiently by manual stretching and maintain them in that position by means of a pair of abdominal retractors. This is not so convenient as the rib dilators, and requires two extra assistants, but it answers the purpose when the dilators are not available.

The anæsthetic, in all lung surgery, is an important desideratum. Wherever possible, I prefer to operate under local anæsthesia. Where this is impossible gas and oxygen, and finally, if necessary, ether. I am convinced that one of the important considerations is to leave the lung after every operation in a condition where its full expansion may be attained at the earliest possible moment. The ideal lung surgery is to provide for a filling up of the pleural cavity by its normal viscus, rather than by dropping down the chest wall to close the cavity. We must therefore provide against extensive effusions, hæmothorax, or long-continued pneumothorax. Our experience in France led us to the conclusion that in traumatism of the chest-wall opening the pleural cavities, it was wise to close the openings in the chest at the earliest possible moment, and I can see no reason why these conclusions should not apply quite as well in civil as in military surgery.

In my article on empyema referred to earlier in this paper, I spoke of the possibility of expanding the lung, even with the chest cavity wide open. I have used this method so extensively that I am thoroughly convinced of its efficacy. It is true that the lung collapses when there is an opening in the chest wall larger than the diameter of the main bronchus. It will remain collapsed so long as the patient remains in complete anæsthesia. If, on the other hand, the anæsthetic is stopped, and the reflexes are allowed to reassert themselves, irritation of the pleura causes coughing, and each time that the patient coughs the collapsed lung dilates. In other words, in the effort of coughing, the air not escaping through the glottis from the healthy lung is forced over into the collapsed lung, and by this means the lung can be expanded to such an extent that it will actually protrude through the wound in the chest. It is my habit, when operating on the chest, to make sure that this expansion of the lung takes place before I close the chest incision.

If the points that I have hinted at in this paper are observed, it is evident that there is no longer any reason why we should not remove tumors of the chest wall involving the pleura, or tumors of the lung itself. There can also be no question that abscesses of the lung and the cavities resulting from bronchiectasis should be attacked and drained. Foreign bodies may be readily removed, but, on the other hand, one would not advocate the removal of a foreign body through the lung that could be reached by means of the bronchoscope.

Lobectomy has now been performed so frequently that it too must be regarded as an established operation. The question of the after treatment of these wounds is important. In all sterile cases, I believe the wound should be closed completely. It is true that in a number of instances we will have a very considerable pleuritic effusion, but this may be withdrawn by means of the aspirating syringe, if necessary. In the abscess cases and the infected cases generally, drainage of course is essential. Frequently it is found preferable to attach the viscera to the parietal pleura at the point of the opening into the abscess cavity, and if a bronchus is open at this point it may be closed at a later operation. The openings into the bronchi are some-

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times difficult to close. An occluding suture will sometimes suffice. In other cases it is essential to do a partial lobectomy. In the lobectomies, I prefer the direct suture method, using a mattress stitch, to the use of the Paquelin cautery. In two of the cases where I employed a Paquelin, the eschar dropped off and caused pleuritic trouble. In cases of hemorrhage of the lung, the indications now are distinctly for an opening of the chest and a direct closure of the bleeding point. This is particularly true if the hemorrhage is of any considerable amount, as the larger vessels in the lung are not controlled by the collapse of the organ.

It is not purposed in this paper to go into the question of empyema, and yet I feel that it would not be complete without a word on this subject. I feel very strongly that we should not have to deal in the future with the chronic empyemas which formerly called for the Estlander and Schede operations, the Fowler-Delorme decortication, the Ransohof gridiron operation, and my own suggestion with regard to the relief of the adhesions. I note in the recent literature a good deal of difference of opinion in regard to when an empyema should be operated upon and yet I cannot help feeling that the profession should be more in accord in regard to this subject than it seems to be. When one considers that an effusion of fluid in the pleural cavity compresses the lung and decreases the aerated surface in proportion to the amount of compression, and that the pleural surfaces become adherent so that the expansion of the lung on the withdrawal or absorption of the fluid becomes impossible, it seems rational at least to urge that operation should be done early enough to prevent this condition. I believe that all effusions which do not show a tendency to decrease, and where the X-ray shows a distinct compression of the lung itself, should be aspirated. The aspirated fluid should be examined, and a careful record made of the bacteriological findings. It is a well-known fact that in the pneumococcus cases, aspiration of even a moderate amount of fluid is often sufficient to provide for a rapid absorption. By means of the X-ray one may determine whether the lung expands after the withdrawal of the fluid. Should the fluid reaccumulate, a second operation should be done, and again the position of the lung determined. Recent adhesions yield readily and allow of a very considerable and finally even a complete expansion. If neglected they become very firm, bind the lung in its abnormal position, and make it impossible for it to expand under any normal respiratory processes. Moschowitz has contended that almost, if not all, of the cases of empyema are due to the rupture of lung abscesses. My experience proves that this is true in the great majority of cases. It is frequently quite possible to make out at the time of operation the point of rupture. The important point to determine, if possible, is when the patient has sufficiently recovered from the pneumonic process to render operative procedure safe. On the other hand, I have operated a number of times and found definite areas of pneumonia, and yet the patient has made a perfectly satisfactory recovery. But there can be no question that the mortality from empyema is very much greater in those cases that are oper-

ated upon during the progress of pneumonia than after the resolution is complete

I wish that medical men would aspirate more frequently and more completely than they do, so that the lung might be relieved from the compression of the effusion. I believe this will render the operation for empyema much simpler and the recovery more complete. An empyema having become an established fact, operation is essential. If it is of recent origin, simple incision through the intercostal space in the most dependent position possible, about the eighth interspace in the posterior axillary line, should be practiced. This can be done readily under local anæsthesia and a drainage tube inserted. If this is not sufficient to allow the lung to expand and the effusion to disappear, it will be necessary to do the more radical operation, and in this case the original incision should be enlarged between the ribs, the ribs separated, and the adhesions broken up or incised until the lung can be made to expand and fill the pleural cavity. If the separation of the adhesions is not sufficient, and the lung still remains collapsed, decortication should be resorted to.

Briefly, we may summarize the present indications for operations on the lung as follows:

First. For tuberculous cavities where gas injections into the pleural cavity, either because of too rapid absorption of the gas or because adhesions prevented the collapse of the lung, extra-pleural thoracotomy should be performed. This may be completed or in stages, depending upon the condition of the patient.

Second. For bronchiectasis, extra-pleural thoracotomy may be performed, although incision and drainage or lobectomy offer a better chance of a radical cure.

Third. For foreign bodies which cannot be removed by bronchoscopy, thoracotomy, with direct removal by incision through the lung, would be the method of choice.

Fourth. For hemorrhage with increasing hæmothorax, compression of the lung and displacement of the heart and mediastinum, thoracotomy with suture of the bleeding point is indicated.

Fifth. For abscess, thoracotomy and drainage of the abscess, attaching the pulmonary pleura about the opening of the lung to the parietal pleura in order to effect direct drainage, will give the best results.

Sixth. For tumors of the chest wall, including the ribs and pleuræ, complete removal with a pediculated skin flap from the abdomen has been successful.

Seventh. For tumors of the lung, thoracotomy and direct excision by partial or complete lobectomy offers the only chance of curing the patient.

Eighth. For empyema, early and frequent aspiration, followed, if necessary, by intercostal incision and drainage.

If these methods are not efficacious, one of the radical operations should be performed.

GANGRENE OF AN EXTREMITY AS A COMPLICATION OF PNEUMONIA

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CASE REPORT—R W, female, aged seven, is one of four children, all of whom are healthy and sturdy. The family history is negative. The patient had "pneumonia" at two years of age and again at five years and at six had whooping cough. Otherwise she has always been well and strong.

On February 12, 1921, she was seen by one of us (E E M) at seven o'clock in the evening. At this time she had a temperature of 105°, pulse 146 and respirations forty and appeared very ill. She was semi-delirious, restless and tossing about. Her cheeks were flushed, alæ nasi dilating with each respiratory movement, she was dyspnoëic, somewhat cyanotic and the usual picture of a pneumonia. Examination of her chest revealed a consolidation of the lower lobe of the left lung. Previous to this, the child had been ill for four days, but had been treated by her parents. The suggestion that the patient be moved to a hospital where better attention could be given, was not acceded to.

The following morning, the child seemed about the same, the lung condition was unchanged and the heart sounds, though fast, were clear and distinct. She was seen in the afternoon and was in about the same condition. At nine P M she was seen and appeared to be in crisis. Stimulation was instituted and the patient carefully watched. A few hours later she seemed better and the next morning had a normal temperature and appeared well over her attack. From this time she was seen daily and continued to improve, the convalescence seeming normal.

On February 17th, four days after the crisis, the patient appeared to be doing nicely and no complications had occurred. In the afternoon she suddenly developed an excruciating pain in the left leg, just above the knee. When seen she had no elevation of temperature, the pulse was increased to 120 and there was nothing abnormal to be seen about the leg. It was placed upon pillows with instructions for it to be kept quiet, as the possibility of a phlebitis was considered.

The following day the leg showed a rather startling condition. It was discolored by large red and blue areas extending from the knee to and including the toes. There was present a definite line above and below which a difference in temperature could be made out. This line was at the junction of the middle and lower thirds of the femur. The leg was decidedly colder than the other and no pulsation could be felt in the leg or foot. Any movement or attempted movement was accompanied by great pain and there seemed to be exquisite tenderness over

the whole thigh and leg The limb was surrounded by hot water bottles and elevated Early in the afternoon of the same day a consultation was held and it was decided to move the patient to the hospital She was taken to Mercy Hospital the day following The gangrene which was of the typical dry type rapidly became more marked and a line of demarcation formed just below the knee, there being an isolated area of gangrene over the patella The thigh was swollen and tender and no pulsation could be felt in the femoral artery

The pulse rate began to increase and as the chest condition seemed reasonably safe, it was thought unwise to wait longer and amputation was performed February 23rd No constriction tests were made of the circulation and no tourniquet was used in the operation Temporary constriction was made by the hands of an assistant and amputation was done just below the middle of the thigh The skin bled fairly freely, the muscles were somewhat pale and the bone marrow decidedly pale, but it was decided to risk it at this level and the subsequent course showed that the structures were viable There were no thrombi in the vessels at the point of amputation and a dissection of both arteries and veins in the specimen showed none The blocking was apparently high in the femoral

The patient's further convalescence was without incident and she left the hospital March 18th in first-class condition At no time was there any evidence of an endocarditis or disease of any other blood-vessel, artery or vein, and no other diseased condition of any type was found

REMARKS

A few years ago, thrombosis of a vein in an extremity as a complication of pneumonia was considered a rarity Da Costa recorded his first case in 1894 and this seems to be the first reported Since then a large number have been described and there is quite a literature on the subject Arterial thrombosis or embolism occurring in an extremity following a pneumonia seems to be extremely rare In fact, embolism of the arteries of the extremities from any cause other than endocarditis is very unusual In the cases of gangrene of an extremity reported as following pneumonia, it has not always been clear whether the condition has been a thrombosis or embolism Gibson, who reported three cases in 1903, and found no mention in the literature of others, thinks the condition an embolic one and that the emboli come from the fibrinous masses which are seen in the pulmonary capillaries and larger venules in the hepatized area Recently, Kline and Winternitz have shown that the capillaries in the consolidated lung are extensively plugged with fibrin This would seem to lend weight to Gibson's theory of the manner of production

The association of a pulmonary condition and an embolism or thrombosis of a peripheral blood-vessel, of course immediately arouses interest as to which is primary and whether the lung condition may not be an infarction This question is a pertinent one in cases where a phlebitis or an endocarditis



FIG 1 —Post-Pneumonic Gangrene of leg

POST-PNEUMONIC GANGRENE

is present, but with an undiseased heart and a clear previous history a clear-cut pneumonia followed by an arterial embolism or thrombosis seems to be cause and effect

It is easy to understand an embolus traveling from the lungs into the left auricle and ventricle out into the systemic arterial circulation, but difficult to imagine an arterial disease (other than endocarditis) giving rise to a pulmonary embolism, with the capillary sieve between

A rather careful search of the literature for the past twenty-five years has revealed very few reports of cases of this condition Gibson reported three in the ANNALS OF SURGERY in 1903 Frazier, in Keen's Surgery, mentions but gives no details of two cases Osler states that he saw one case and mentions Kredel's case of popliteal thrombosis and speaks of Seidelmann's case of gangrene of fingers and thumbs of both hands He also mentions Hjelt's case of embolism of the abdominal aorta and Aldrich's case of embolism of the lenticulo-optic artery Dr Wm F Lockwood (personal communication) relates a case of gangrene of the arm following pneumonia Dr Mercur of Pittsburgh (personal communication) tells of a case similar to the one herewith reported, except there was a possibility of an endocarditis in his case

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CENTRAL BONE ABSCESS*

BRODIE'S ABSCESS, CHRONIC SUPPURATIVE OSTEOMYELITIS

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THE recognition of central isolated bone abscesses has received scant attention and reported cases are few in number. The process is simple and its pathology well understood. The main difficulty seems to be in its differential diagnosis. It must be differentiated from bone cysts and tumors, syphilitic osteitis and periostitis, and bone tuberculosis. When recognized and properly treated, its cure is certain. The diagnosis is made by the long duration, periodicity, and characteristic symptoms of pain at night in association with the X-ray picture. Too many of these abscesses are unrecognized and the patients are condemned to needless and prolonged suffering.

Pathology—In its simplest form a Brodie abscess is a small, well localized, circumscribed, pyogenic abscess situated deeply in the medullary cavity or cancellous tissue of a long bone, without any external fistula or sequestration, and it is characterized frequently by an extensive productive osteitis, often of many years' standing.

There are two general locations for them, first, in cancellous bone, giving in the X-rays a central, translucent area (Fig 2), surrounded by dense bone, and a second variety, situated in the medullary cavity (Fig 1), evidenced in the X-rays by the presence of a uniform, diffuse swelling of the bone which looks like an exuberance of normal bone. There is no resemblance to new growths. In the medullary situation there may be no translucent area in the centre of the sclerosed bone (*e.g.*, Fig 1), as we find in Brodie abscesses in cancellous tissue, or there may be such an area (Figs 3 and 4). The medullary cavity may be much diminished in diameter by the production of new bone on the endosteal surface while above and below the medullary cavity is entirely shut off from the remainder of the cavity by new bone. Thus, nature limits the spread of the infection. In the medullary abscess the pus is often slight in amount, and this, in association with the small destruction of bone about the abscess, together with the production of dense, surrounding new bone, may result in there being no translucent, central area evidenced in the roentgenogram (Fig 1). In the cancellous variety (Fig 2), on the other hand, the spongy bone becomes easily necrosed and there is a liquefaction of the necrosed particles, leaving behind a definite cavity seen in the roentgenogram. There may be a single, small cavity or there may be several small cavities. There may be large, solitary cavities (Fig 2), reaching the size of a pigeon's egg or a hen's egg. These large, solitary cavities are usually

* Read before the New York Surgical Society, May 11, 1921.

found in the metaphyses There is no tendency to sequestration though the lesion extends over many years

Complications—Infrequently a spontaneous fracture may occur in case the new bone formation is less than the bone destruction A sudden fall, or trauma, may wake up the latent virulency of the infection, or break the abscess capsule, so that a typical acute osteomyelitis may result Some of the misconceptions of the lesion are shown in these quotations Stewart's Surgery, Edition of 1921, states that "Brodie's abscess is a tuberculous abscess near the epiphysial line of a long bone" Keen's Surgery, vol 1, page 285, says, "Tuberculous abscesses of the long bones nearly always occur in the epiphyses rather than the diaphyses, the head of the tibia being a favorite site (Brodie's abscess)" It is thought generally that Brodie attributed these bone abscesses to tuberculosis, but there is not a suggestion in the appended quotations from Sir Benjamin that he thought this to be etiology There is as much truth in this observation, probably, as there is in the equally fallacious statement that most ischio-rectal fistulæ are tuberculous Brodie's abscess is caused by pyogenic organisms, most frequently staphylococci

To illustrate how incomplete the knowledge of even the X-rayist is, I quote from the latest X-ray book on "Injuries and Diseases of Bones and Joints," by Baetjer & Waters, Hoeber, 1921 All that they say of Brodie's abscess on page 168 is this "In a certain number of cases we shall find a single, punched-out area, definitely circumscribed, situated in the *cancellous* head of a bone about an inch from the joint Such a localized osteomyelitis we speak of as Brodie's abscess The upper ends of the tibia and humerus seem to be the favorite locations for such conditions"

I was much interested in looking up Sir Benjamin Brodie's account of his discovery of this lesion in his book, published in 1850, entitled, 'Pathological and Surgical Observations on the Diseases of the Joints' On page 288 he gives his account of how he discovered the lesion

"Occasionally chronic inflammation of the articular extremity of the tibia terminates in the formation of an abscess in the centre of a bone, but contiguous to the joint An abscess of this kind is attended with an extraordinary degree of suffering, such as not only would justify amputation, *if there were no other means of obtaining relief*, but would induce the patient cheerfully to submit to operation Fortunately a less formidable mode of cure is within our reach My first knowledge of this disease was derived from the following case

"The patient was twenty-four years of age, and was first seen in October, 1824, who had had pains of excruciating character for twelve years All treatment failed, so finally he made up his mind to have the limb amputated, which was done On examining the amputated limb, it was found that a quantity of new bone had been deposited on the surface of the lower extremity of the tibia The deposition of new bone was manifestly the result of inflammation of the periosteum at some former period It was not less than one-

third of an inch in thickness, and, when the tibia was divided longitudinally with a saw, the line at which the new and old bone were united with each other was distinctly to be seen. The whole of the lower extremity of the tibia was harder and more compact than under ordinary circumstances, in consequence, as it appeared, of some deposit of bone in the cancellous structure, and in its centre, about one-third of an inch above the ankle, there was a cavity of the size of an ordinary walnut, filled with a dark colored pus. The bone immediately surrounding the cavity was distinguished from that in the neighborhood by being of a whiter color, and of a still harder texture, and the inner surface of the cavity presented an appearance of great vascularity. The ankle-joint was free from disease.

"It seems highly probable that, if the exact nature of the disease had been understood, and the bone had been perforated with a trephine, so as to allow the pus collected in its interior to escape, a cure would have been effected without the loss of the limb, and with little or no danger to the patient's life. Such, at least, was the opinion which the circumstances of the case led me to form at the time, and I bore them in my mind, in the expectation that, at some future period, I might have the opportunity of acting on the knowledge which they afforded me, for the benefit of another patient.

"The second patient (page 292) was a man, twenty-three years of age, who was seen in February, 1826. It was regarded as a case of chronic periostitis and was treated for this by incision only, without penetrating the bone. A second operation was necessary because of lack of relief, in which the bone was trephined and the abscess opened, with a cure." But let us abstract Brodie's account of this case which cleared up the pathology for him. "Mr B, at that time twenty-three years of age, consulted me in the beginning of February, 1826. There was considerable enlargement of the right tibia, beginning immediately below the knee, and extending downwards, so as to occupy about one-third of the length of the bone. He complained of excessive pain, which disturbed his rest at night, and some parts of the enlarged bone were tender to the touch. The knee itself was not swollen, and its motions were perfect. He said that the disease had begun more than ten years ago, with a slight enlargement and pain in the upper extremity of the tibia, and that these symptoms had gradually increased up to the time of my being consulted. Various remedies had been employed, from which, however, he had derived little or no advantage.

"Having inquired into the circumstances of the case, I was led to regard it as one of chronic periostitis, and I adopted the following method of treatment. An incision was made longitudinally on the anterior and inner part of the tibia, extending from the knee four inches downwards, and penetrating through the periosteum into the substance of the bone. The periosteum was found considerably thickened, and the new bone, which had been deposited beneath, was soft and vascular. The immediate effect of the operation was to re-

lieve the pain which the patient suffered, so that he slept well on the next and every succeeding night After this I prescribed for him a strong decoction of sarsaparilla The wound gradually healed, and it was for some time supposed that a perfect cure had been accomplished The enlargement of the upper extremity of the tibia, however, never entirely subsided, and in August, 1827, pain was once more experienced in it At first the pain was trifling, but it gradually increased, and when I was again consulted, in January, 1828, Mr B was unable to walk about, and quite unfit for his usual occupations At this period the pain was constant, but more severe at one time than at another, often preventing sleep during several successive nights The enlargement of the tibia was as great as when I was first consulted, and the skin covering it was tense, and adhering more closely than is natural to the surface of the bone Some remedies which I prescribed were productive of no benefit The patient's suffering was excruciating, and it was necessary that he should, if possible, obtain immediate relief The resemblance between the symptoms of this case and those of the first case described was too obvious to be overlooked It appeared highly probable that they depended upon the same cause, and I therefore proposed that the bone should be perforated with a trephine, in the expectation that an abscess would be discovered in its interior To this the patient readily assented, and, accordingly, the operation was performed in the beginning of March, 1828

"My attention was directed to a spot about two inches below the knee, to which the pain was especially referred This part of the tibia was exposed by a crucial incision of the integuments The periosteum now was not in the same state as at the time of the former operation, it was scarcely thicker than natural, and the bone beneath was hard and compact A trephine of middle size was applied, and a circle of bone was removed, extending into the cancellous structure, but no abscess was discovered I then, by means of a chisel, removed several other pieces of bone at the bottom of the cavity made by the trephine As I was proceeding in this part of the operation, the patient suddenly experienced a sensation, which he afterwards described as being similar to that which is produced by touching the cavity of a carious tooth, but much more severe, and immediately some dark-colored pus was seen to issue slowly from the part to which the chisel had been last applied This was absorbed by a sponge, so that the quantity of pus which escaped was not accurately measured, but it appeared to amount in all to about two drachms From this instant the peculiar pain belonging to the disease entirely ceased, and it has never returned The patient experienced a good deal of pain—the consequence of the operation—for the first twenty-four hours, after which there was little or no suffering The wound was dressed lightly to the bottom with lint Nearly six months elapsed before it was completely cicatrised, but, in about three months from the day of the operation, Mr B was

enabled to walk about and attend to his usual occupations. He continued well when I last saw him on the 7th of January, 1832, and the tibia was then reduced in size, so as to be scarcely larger than the other leg. No exfoliation of bone had ever taken place.

"Since the occurrence of this case, five similar cases have come under my care, in every one of which a complete cure was at once obtained by the same operation, so that I have the satisfaction of knowing that in my own practice as many as six individuals have been enabled to preserve limbs which must inevitably have been amputated if the dissection of the limb in one other case had not made me acquainted with the real nature of the disease under which they laboured."

GENERAL OBSERVATIONS BY BRODIE (PAGE 296)

"Chronic abscess of the extremity of the tibia may exist during a very long period before it interferes with the neighboring joint. In one case the patient had labored under the symptoms of the disease for as many as eighteen years before I was consulted. The symptom by which the disease is indicated in the first instance is pain in the affected part, which is more or less of an intermitting character. The pain gradually becomes more severe, but still it is intermitting. For some time the patient may suffer so little from it that he is not prevented from attending to his usual occupations, then, without any manifest reason, a paroxysm occurs, in which the pain is intense, he is utterly disabled, and even unable to quit his bed. This gradually subsides and he has another interval of ease. As the disease goes on, the bone becomes increased in size, the general health becomes affected, and the mind probably is rendered miserable and irritable by long-continued suffering. In one case, whenever the patient began to use the limb the knee itself became inflamed, and there was an effusion of fluid into the cavity of the synovial membrane. The case of Hendrow, already recorded in the sixth chapter of the present volume, explains the probable cause of this complication to have been the attempt of the abscess to make its way into the knee-joint, through the cartilage of the tibia. If, in this case, the application of the trephine had been much longer delayed, we cannot doubt that the joint would have been destroyed, and that there would have been no means of relieving the patient except by amputation.

"Now, I do not say that in all cases in which the combination of symptoms exists which I have just described, the surgeon should at once conclude that there is an abscess in the interior of the bone, and that the trephine should be applied for the purpose of making an opening into it. For the most part there can be no danger in deferring the operation until it has been ascertained whether such remedies as mercury, sarsaparilla, or iodide of potassium (which are known to have the power of subsiding chronic inflammation of bone), will afford the desired relief. But if these methods fail, I cannot doubt that it is the duty of the surgeon to perforate the bone

with the trephine Hitherto, in no instance in which I have performed the operation have I failed in discovering the abscess But, even if abscess should not exist, I can conceive that the perforation of the bone, by relieving tension, and giving exit to serum collected in the cancellous structure, might be productive of benefit, and at all events the operation is simple, easily performed, and cannot itself be regarded as in any degree dangerous "

Symptoms.—Brodie's abscesses are usually found in adults There is frequently a history of osteomyelitis in childhood which is almost forgotten "Growing" pains in childhood should be looked upon with suspicion and should not be dismissed with the casual diagnosis of "rheumatism" This is particularly true if the pain is localized to one spot Rontgenograms should be taken to rule out foci of infection or tuberculosis

In Brodie's abscess, after some trauma, or severe bodily exertion, or without any recognized etiology, a dull ache appears in some localized area, to become boring and severe, much worse at night, being apparently accentuated by the warmth in bed A characteristic symptom is that the pain comes and goes, sometimes worse in wet weather, hence the etiology is referred to as "rheumatism" There is frequently a definite, localized, unvarying spot of tenderness on pressure over a particular locality, or there may be no localized point of tenderness There may be an occasional slight rise in temperature, but this is not constant The most frequent locations for such abscesses are the head of the humerus, femur, and tibia, and the shafts of the humerus, radius, femur, and tibia The pain frequently extends over a period of many years When near joints, there may be muscular spasm, and an intermittent hydrops of the joint

A rontgenogram should clear up the diagnosis In both the cancellous and medullary Brodie abscesses, there is an overdevelopment of dense bone, usually producing a swelling of the bone In the centre of this dense bone, in the medullary type, there may or may not be a central, translucent area, the abscess itself If there be this translucent area, then the diagnosis is at once evident Frequently there is no light central area, and then the mistaken diagnosis is usually made of syphilitic periostitis If the Wassermann is negative, then the bone should be opened (see Case II) If the Wassermann is positive, then intensive antisyphilitic treatment (salvarsan intravenously, mercury injections, potassium iodide by mouth) should be given The pain will very quickly disappear if the process is syphilitic If there is a Brodie abscess combined with constitutional syphilis, then the pain will not be relieved by the antisyphilitic treatment, then the bone should be opened and the abscess drained In the cancellous type, there is apparently always a central translucent area, though I know of no reason why it may not be absent

Alexis Thompson (*Edinburgh Medical Journal*, New Series, Vol XIX), has analyzed 161 cases Out of 145 cases, in which the early history was

available, there had been an antecedent osteomyelitis in childhood in 122. The most frequent bone affected was the tibia. Seventy-four per cent of all the abscesses were in the tibia.

LOCATIONS		
Tibia,	Upper end	63
	Lower end	42
	Upper and lower	1
	Middle third	2
	Not stated	11
		<hr/>
		119, or 74 per cent
Femur	18, or 11 per cent	
Humerus	18, or 11 per cent	
Radius	4, or 3 per cent	
Ulna	2, or 1 per cent	

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INCIDENCE OF BRODIE'S ABSCESS

In the Presbyterian Hospital since 1913 (seven years), there have been 115 cases of chronic, suppurative osteomyelitis of the long bones. Among these were found three cases of undoubted Brodie's abscess, or 2.6 per cent. Several were uncertain, so were excluded.

Differential Diagnosis—Syphilitic osteitis and periostitis may be ruled out by a negative Wassermann, and the lack of a history of infection. A somewhat similar area of softening sometimes occurs with gummata, but in this case the surrounding bony wall is then soft and not ivory-like. The associated night pains in syphilitic osteitis are very similar to those in Brodie's abscess, but in the latter they are more intermittent and changeable in intensity, while in the former the night pains, when once they have begun, are persistent and increase in a consistent ratio, finally becoming intolerable. Probably the commonest mistake is in referring the pains due to Brodie's abscess to "rheumatism."

Bone cysts lack the surrounding sclerotic bone, and there is an absence of night pains, with no increased temperature, nor is there any local tenderness. Bone tumors are not to be confused with Brodie's abscess because of the irregularities in the shadows caused by the soft tissues having imbedded in them plaques of bone, and there is a thinning out of the normal bone caused by the pressure of the tumor. Tuberculosis of bone is essentially a destructive process and leads early to sinuses and sequestra, and there is an absence of evenly sclerosed bone such as occurs in Brodie's abscess, which is a constructive lesion. The periosteum is rarely thickened in tuberculosis of bone. These cases have been treated for neuritis, sciatica, rheumatism, syphilis, etc.



FIG 17 — Case I Medullary variety Anteroposterior view. No central translucent area indicating abscess. Operation showed that abscess was so small to be apparent. The whole diameter of bone seems to be only enlarged.

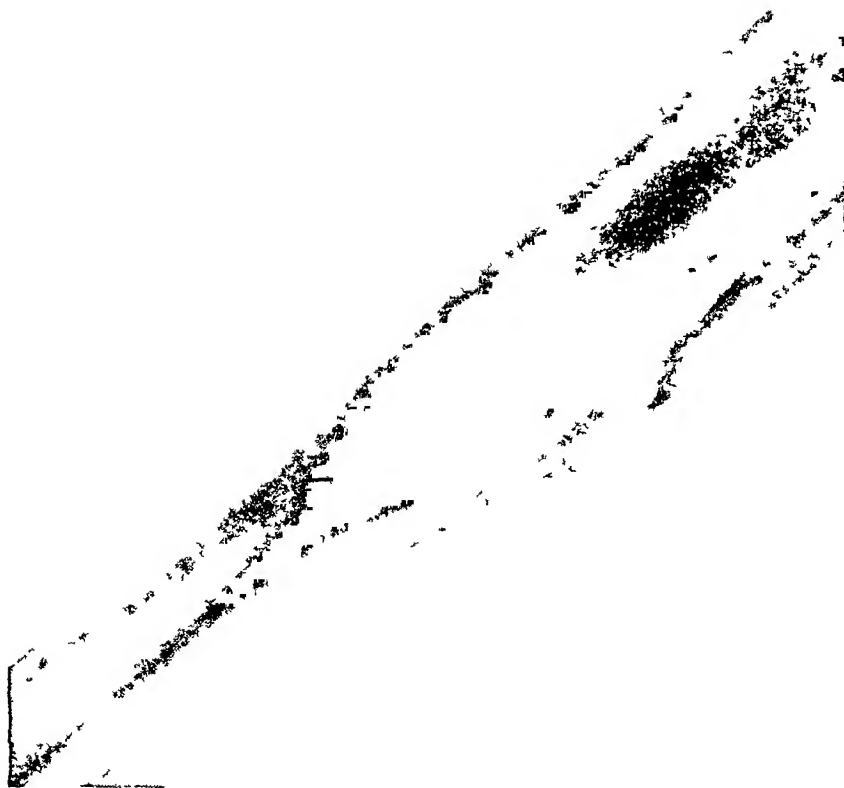


FIG 1b—Case I Lateral view The new production of bone seems to be larger on outer side



FIG. 10.—Case I. Shows the 4-inch furrow made through the bone opening the abscess located in the medullary cavity.



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FIG. 2.—Case II. Cancellous variety. Large solitary abscess seen in lower tibia surrounded by dense new bone. Kindness of Doctor Imboden. The patient had been treated for four years intensively for syphilis without any relief of his severe night pains.

CENTRAL BONE ABSCESS

CASE REPORTS CASE I (Fig 1) —The patient was a man of twenty-one years of age who had never been sick with typhoid, pneumonia, scarlet fever or osteomyelitis. He was a college student, athletic, and in the best of health. Thirteen years ago he was operated upon for acute appendicitis and two years ago for inguinal hernia. Three years previously he received a stab wound on the middle of the right tibia which healed up in three or four days without pus formation. Two years ago he began to have a dull ache in the right tibia, which later became boring in character, worse at night and after strenuous bodily exertion. The pain would come and go and was diagnosed as "rheumatism." Six months ago the pain became much worse, keeping him awake at night. A roentgenogram was taken by a Western surgeon which showed the same tibial enlargement as in the present radiograph, but that surgeon said that he did not know what the swelling was due to, also another surgeon expressed his ignorance of the etiology. Early in April, 1921, the patient came into the author's hands. His pain had become worse so that he would rarely have an undisturbed night's sleep. There was a slight swelling, palpable, on the middle of the right tibia, evidently an enlargement of the bone, but it was not tender and there was no localized point of tenderness. The location of the pain seemed to be fugitive. Wet weather did not seem to influence the pain, but physical exertion increased it. A radiogram was taken and showed a uniform, fusiform swelling, three inches long, on the middle of the right tibia, involving the whole circumference of the bone, but more prominent on the outer side of the bone. There was no central translucent area. The X-rayist made a diagnosis of syphilitic osteitis. A Wassermann blood test was negative. The author then made a probable diagnosis of Brodie's abscess and operated upon the man, after applying a tourniquet about the mid-thigh, by a vertical incision, six inches long, carried to the bone. The periosteum was normal, not thickened, and not more than normally adherent. It was reflected from the bone on either side and a groove was made in the enlarged area through dense, sclerosed bone. An abscess was finally opened in the medullary cavity, which was of the diameter of a quill and was three inches long. The walls of this cavity were smooth, with no covering granulation tissue nor any endosteum. The whole thickness of the entire cortex was very dense, hard, and enlarged. Above and below, the medullary cavity was shut off from the remaining medullary cavity by dense, new bone. The fluid in the cavity was thin and whitish, and all that remained of the marrow tissue was some whitish strings which looked like fibrin. A furrow (Fig 1, C) was made through the whole length of the dense, eburnated, anterior wall, three inches long and half-an-inch wide. Cultures were taken of the pus, and the stringy, fibrinous tissue was removed. No curetting was performed of the smooth walls, in which there was no sign of any sequestration. The upper part of the wound was closed with silkworm-gut sutures, and through the lower part

were placed three Carrel tubes, without any packing, but with vaselined gauze along the wound edges Dakin's solution was thereafter instilled every two hours On the fourth day no organisms were found in smears, so that the wound was entirely closed secondarily (fourth day postoperatively) with gas and oxygen anæsthesia, without drainage The cultures taken at the time of the original operation were contaminated, so the causative organism is unknown, though probably it was staphylococcus, which is the most frequently found etiology in these abscesses

CASE II (Fig 2) —Was kindly given to me by Doctor Imboden It shows a large, solitary abscess in the cancellous tissue of the tibia near the ankle-joint The man was fifty years of age and had been treated for four years very intensively for syphilis without any benefit Drainage of the abscess resulted in a cure

CASE III (Fig 3) —A man thirty-five years of age, had typhoid fever twelve years ago Soon after, he began to have severe shooting pains in lower third of right tibia which prevented sleep at night Recurring attacks of night pains, coming and going Present attack has lasted for five weeks, slight tenderness over bony swelling of tibia Examination shows a two-inch-long moderately tender thickening of the middle of the right tibia In the centre of the sclerosed bone is seen a central translucent area in the radiogram

Operation by Doctor Darrach, February 1, 1916 There was a cavity in the centre of the tibia, 3x4x4 cm, containing thick, yellow pus without odor It was lined by pale red granulation tissue The cortex of the bone was thickened and was hard The bone was drilled with the Albee drill over the thickening Thick pus escaped at the second drilled spot The bone was removed over the cavity and a Mosetig-Moorhof iodoform plug filled the cavity A culture of pus showed bacillus typhosus The patient resumed work two months after being discharged The sinus discharged for one year after the operation, under the old method of packing, despite the iodoform plug Brickner says (ANNALS OF SURGERY, vol lxxv, 1917, page 485), "I have not found recorded any case of pure medullary abscess of typhoid origin" Case III is such an instance He also says that the medullary abscess cannot be recognized as such roentgenographically, because of the lack of translucent central area Cases III and IV are instances of medullary abscesses with central translucent areas, easily made out in the radiograph

CASE IV (Fig 4) —R G, History 17142 A man aged twenty-five years February 4, 1913 Doctor Eliot Nineteen years ago he fell, severely injuring the right shin, below the knee Pain lasted for six weeks Four years after this a sudden attack of severe, lancinating pain in the same spot This lasted for two nights, then two years ago a similar attack, lasting three nights One month ago, the same area had severe pain which has persisted, much worse at night The bone has become gradually swollen, examination shows a fusiform, slightly tender swelling of the upper third of the right tibia



FIG 3—Case III Typhoidal medullary variety with central translucent area. Note the sclerosed bone surrounding the central collection of pus. Abscess caused by bacillus typhosus twelve years after the original infection.



FIG 3—Case III Cavity filled with Mosetig-Moorhof iodoform plug. With this method of treatment patient had a sinus for one year.



FIG 4—Case IV Medullary abscess with translucent central area surrounded by dense bone in upper portion of tibia

CENTRAL BONE ABSCESS

X-ray showed dense osteitis with translucent central area. That leg measures 4 cm more in diameter than the opposite one. At the operation (Doctor Eliot), the upper third of the tibia was found very much hypertrophied, and in the medullary cavity, just below the tubercle of tibia, was a small pus pocket, culture of which gave a pure growth of staphylococcus aureus. An opening was made through the bone to the abscess cavity, which was allowed to fill with blood clot, and it was covered by rubber tissue. No record of after history.

Treatment.—The old, classical treatment was opening of the abscess through the dense bone followed by packing, the wound being allowed to granulate up from the bottom. This required months before healing was complete. Bevan advanced the treatment to immediate closure, following swabbing out with hydrogen peroxide and then 70 per cent alcohol. His results were excellent. It occurred to me that our knowledge, gained during the war, of secondary suture of infected wounds might well be applied here, following a sterilization with Dakin's solution. This seems a little surer than Bevan's method, and does not delay the healing more than four or five days. The closed cavity is left to fill up with the blood clot.

In Case I there was primary union of the entire wound, and the lad was discharged, cured, on the twelfth day, and he has remained cured since.

Literature.—The literature on this subject is scant. It is usually grouped under chronic suppurative osteomyelitis, so that one must wade through the voluminous literature of this large subject to find instances of Brodie's abscess. It would be better, in my opinion, if a distinct, separate heading were to be made in our classifications for this entity, which presents a very different picture from the acute, or the usual chronic, suppurative osteomyelitis.

BEVAN (*Surg. Clin. of Chicago*, June, 1919, p 743) reports two cases, both of the medullary variety, and gives his method of immediate closure.

MILLER (*ANNALS OF SURGERY*, 1918, vol lxvii, p 460) reports a case of the medullary variety, with remarks.

MARTIN (*ANNALS OF SURGERY*, 1917, vol lxvi, p 254) reports three cases in a few lines. He does not state specifically to which variety the three cases belong, but says that in these three cases the radiographs failed to differentiate the abscess cavity from the shadows made by the thickened, sclerotic bone, hence one may infer that they belonged to the medullary variety.

DOWD (*ANNALS OF SURGERY*, 1906, vol lxiv, p 112) reported a patient with Brodie's abscess who had symptoms for nine years. It was of the medullary variety, with a central translucent area surrounded by dense bone.

BRICKNER (*ANNALS OF SURGERY*, vol lxv, 1917, p 483), in an interesting and instructive article on Brodie's abscess, cites three cases, all of the medullary variety.

BRYANT and BUCK, vol iii, p 316, give an excellent account of Brodie's

abscess, and in vol III, p 289, there is a roentgenogram of a Brodie's abscess with a central, translucent area in the lower end of the radius, and on p 321 they narrate the case of a man with a Brodie abscess in the upper fifth of the shaft of the femur

ALEXIS THOMPSON (*Edinburgh Medical Journal*, New Series, vol XIX) has collected and analyzed 161 cases of Brodie's abscess

CONCLUSION

Given a tender swelling of a bone in which traumatic periostitis, cyst, new growth and syphilis (negative Wassermann) can be ruled out, when associated with intermittent night pains, such a swelling should always be explored and the medullary cavity opened. The soft parts should then be closed over the cavity except for space sufficient to allow Carrel's tubes to be inserted. Dakin's solution should then be used through the tubes every two hours until smears show an absence of organisms, when the cavity can be completely closed with confidence that the wound will promptly heal without a sinus forming.

PEPTIC ULCER, PRIMARY AND SECONDARY*

BY JOHN B. DEEVER, M.D.

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THE operation of gastroenterostomy, in about two per cent of cases, is followed by secondary ulcer, marginal, or at the margin of the new opening, or jejunal, at a point distant to the opening. According to Gosset it was not until 1899, seventeen years after the operation of gastroenterostomy had first been performed, that the first case of jejunal peptic ulcer was described. The case was reported by Braun, and concerned a patient who had developed this unpleasant aftermath one year after the gastroenterostomy had been done.

Statistics show that these ulcers may occur from a few days to many years after the primary operation. The shortest known interval is ten days, while at the other extreme, seven years are known to have elapsed between operation and secondary ulcer formation. These ulcers present the same characteristics as the primary ulcers and like them may perforate into the free peritoneal cavity or develop fistulous connections with other viscera. In a series of seventy-nine jejunal ulcers reported by Gosset, twenty-four had perforated, and thirteen had developed internal gastric fistulas, of the latter ten were jejuno-colic, one gastro-colic, and two jejuno-gastro-colic.

Primary peptic ulcer arises in the portion of the alimentary canal where gastric juice is normally present. The duodenum is the most frequent site, the stomach is involved about one-fourth as often as the duodenum, while primary jejunal ulcer is a very rare occurrence. These ulcers may be acute or chronic.

The acute peptic ulcer is primarily a medical condition, the treatment of which has been so carefully developed by Sippy and his followers. Einhorn's duodenal bucket also represents a useful therapeutic agent in the treatment of these ulcers, inasmuch as it enables nourishment to be given to patients who are unable to take it in the natural way. This affords temporary relief, and if operation is resorted to, it has helped to bring the patient to a state where surgery will be not only safer but in all probability curative.

As a preparation for operation medical treatment of chronic ulcer also has its usefulness, in fact in many instances this is the wisest course to pursue, but it has its distinct limitations, for in the last analysis the chronic indurated callous peptic ulcer belongs to the domain of the surgeon. Prolonged medical treatment of this type of ulcer is what I would term pussyfooting, in other words it is courting disaster in the shape of hemorrhage, perforation and, in a certain percentage of cases, carcinoma.

While opinions differ as to the question of carcinoma developing on ulcer, the surgeon who does a large number of operations for the treatment of peptic ulcer, and who has submitted the removed ulcers to microscopic study, realizes the danger to be one that has to be reckoned with.

* Read before the New York Physicians' Association, December 23, 1920.

It is after the surgical treatment of peptic ulcer, either by gastroenterostomy alone, or combined with excision of the ulcer, or by pylorectomy, partial gastrectomy, or subtotal gastrectomy, that medical treatment has its greatest field. It takes three weeks or more for the margin of a gastroenterostomy to heal. In order, therefore, to obtain the best results from surgery, it is of the utmost importance to institute judicious medical treatment, mainly in the form of alkalies, immediately after operation and to continue it for at least a month. The administration of alkalies after a posterior gastroenterostomy is adopting nature's manner of neutralizing the acid gastric juice through the medium of the bile and the pancreatic secretion which reaches the stomach by way of the new stoma. This is generally considered to be the rationale of the cure, and not the drainage of the new opening, or the putting of the ulcer, if not excised, at rest.

If, after a gastroenterostomy, with an open pylorus, the stomach, whose secretion is highly acid, empties more freely by way of the new opening, the conditions are favorable for the formation of secondary ulcer at or near the gastrojejunostomy. This naturally leads to the question of the cause of these secondary ulcers. The consensus of opinion is that they are of toxic origin, due to embolic infection from a primary focus, such as the mouth, the tonsils, the teeth, and the appendix. I can only repeat my frequently stated belief that the appendix is the most common source of such infection. Furthermore, the arrangement of the terminal vessels along the lesser curvature of the stomach favors embolic obstruction, while necrosis, or a break in the continuity of the mucous membrane together with exposure of these lesions to the corrosive action of the gastric juice completes the setting for the drama. Chronic and subacute appendicitis followed by primary peptic ulcer is not unusual. That duodenal or gastric ulcer may be followed by perforation of a chronically diseased appendix is well illustrated by the following case.

Male, aged sixty-five years, admitted to the Lankenau Hospital, Philadelphia, giving a typical history of gastric ulcer symptoms of many years' duration, which were preceded by symptoms suggestive of chronic appendiceal dyspepsia. A diagnosis of gastric ulcer was made and operation advised and consented to. At operation a large chronic indurated ulcer was found on the middle of the lesser curvature of the stomach, the pylorus being patulous, a circular sleeve resection was made with end-to-end anastomosis. The operation was one of considerable moment and the patient's condition was none too good. After the resection was completed I carried my hand down to the site of the appendix, the cæcum could not be lifted with ease and in view of the patient's condition it seemed best to stop here and close the abdomen. Six days later there was evidence of oncoming peritonitis, accompanied by exacerbation of pain, hiccough and nausea, but no vomiting. Peristalsis was subnormal in the lower and exaggerated in the upper abdomen, there was marked tenderness to rectal touch, and difficulty in emptying the bladder. The patient had some enlargement of the prostate but had had no trouble in passing urine before the present condition. My first thought was leakage at the line of the stomach

suture, with peritonitis and intestinal paresis, but on second thought the presence of marked rigidity and tenderness in the appendiceal region suggested a ruptured appendix. The latter proved to be correct, for at operation the ruptured appendix was found, with pus in the pelvis and also pathological evidence of chronic disease. After removal of the appendix and drainage, the patient made an uneventful recovery.

Ulceration of the proximal jejunum occurs very rarely independently of operation. Ulcers occurring on the jejunum and not far distal to the gastrointestinal anastomosis are closely related etiologically to those which develop at the gastroenterostomy site itself and which are spoken of as gastrojejunal or marginal ulcers. I can see no very good reason for separating these two types of ulcer pathologically, though their symptomatology is usually distinct.

The jejunal type of post-operative ulcer is more prone to acute perforation than is the gastrojejunal or marginal ulcer. This type of ulcer was formerly relatively more frequent than the gastrojejunal or marginal ulcer, since many more anterior than posterior gastrojejunostomies were done in the early period of gastric surgery. The underlying disease which caused the original ulcer may also be responsible for the jejunal or the gastrojejunal or marginal ulcer. Other causative factors comprise defect in the mechanics of the operation, or in the material used for suture, or the highly acid gastric juice, or the presence of adhesions at the site of the anastomosis.

The greater frequency of gastrojejunal or marginal ulcer after anterior gastrojejunostomy and after posterior long-loop operations in which no entero-anastomosis was done, lends support to the theory that they are due to the corrosive action of the hyperacid gastric juice, as does also the less frequent occurrence of marginal ulcer where a gastroenterostomy has been made in the presence of low acidity or anacidity.

The symptomatology of the condition is not greatly unlike that of the original ulcer. The radiographic proof of some obstruction of the new opening is very important evidence. While gastrojejunal or marginal ulcer is the most common cause for a recurrence of symptoms approaching in severity those before the operation and which were relieved by the operation, we must not lose sight of the fact that the nervous individual, the subject of chronic ulcer and upon whom operation is done, will not lose all of his nervousness and therefore will still complain. Here again where a diagnosis of marginal ulcer has been made it is not out of place to try a course of medical treatment before subjecting the patient to operation, which in the end is generally the only thing that will offer permanent relief, provided the diagnosis is correct.

The medical treatment of secondary ulcers is, of course, the same as for the primary disease. Einhorn claims to have brought about a cure in some instances by introducing nourishment by means of the duodenal bucket passed through and beyond the gastroenterostomy opening, which at the same time puts the ulcer at rest.

Treatment.—In the surgical treatment of any form of peptic ulcer it is

understood that all foci of infection are to be removed whenever possible. The treatment of gastrojejunal or marginal ulcer to be curative must be operative.

The nature of the operation and its gravity will depend upon the following factors: the condition of the patient, the previous operation, the extent and degree of organization of adhesions, the degree of exudate surrounding the ulcerated area, and the presence of a fistulous connection with a neighboring viscus.

The condition of the patient calls for practically all the routine examinations used in the primary cases, namely, blood pressure, blood count, serological examination, the various kidney functional tests, possibly also the preparation for direct blood transfusion, and of course X-ray and fluoroscopic study. The latter are of the utmost importance in determining the probable amount of surgery that may be called for. In some cases a careful pneumoperitoneal study may be made. As in all surgical cases, the pre- and post-operative treatment are as important as the operation itself.

The first step in the operation is the treatment of the adhesions (if present) before the ulcer can be demonstrated either by sight or by palpation. In disposing of adhesions only those should be disturbed that interfere with good exposure of the field, or in other words, only those that will help to make the geography of the field and the operation to be performed more certain. The field of the anastomosis can be examined by displacing the transverse colon with the great omentum upward. If the ulcer cannot be definitely located and recognized it will be better to make an anterior gastrotomy and evert the site of the anastomosis, when any existing doubt can be dispelled and the truth revealed. What to do with the ulcer will depend upon its size, location, appearance, the amount of induration and the degree of involvement, if any, of the transverse colon and the presence of a fistulous tract.

In the case of a small ulcer with little or no induration, simple excision or destruction with the cautery, preferably through a gastrotomy wound, followed by closure will suffice. Sometimes the ulcer is so large that in excising it there is danger of encroaching upon the peritoneal cavity. In such instances it is important to provide against leakage by suturing either the proximal or the distal limb of the jejunum to the stomach, well beyond the opening. Where this is not feasible, it will be best to excise the anastomosis, this entails the removal of the part of the stomach included in the ring around the anastomotic opening, and division of the proximal and distal limbs of the jejunum close to the opening. With the anastomosis and the ulcer exposed the first step in the dissection is the separation of the transverse mesocolon from its attachment to the stomach, this may be comparatively easy, or it may be very difficult, depending entirely upon the extent and degree of induration surrounding the ulcer, also the presence of a fistulous communication with the colon, the stomach or the small intestine, the presence of a fistula will indicate the necessity of making a partial or complete excision of the viscus in-

volved When the margin of the opening in the transverse mesocolon has been fastened to the limb of jejunum making a part of the anastomosis, or to the line of suture of the jejunum and stomach, the separation is rendered both difficult and uncertain and it is not necessary for me to say adds materially to the seriousness of the operation Therefore, it is my practice in making a posterior gastroenterostomy to make the opening in the transverse mesocolon nearer to the vertebræ than to the colon, so that in the event of a marginal ulcer the ulceration would not be so likely to encroach upon the colon This may or may not be of moment But I believe it is important especially if conditions later on make it necessary to separate the transverse mesocolon from its attachment to the stomach, as above referred to

The anastomosis, including its immediate pathology, having been cut away, the rest of the procedure will depend upon the presence or absence of the pylorus, and if present, its patency

In the presence of an open pylorus and no evidence of further ulceration of the stomach it is my practice to close the opening or openings in the stomach and unite the ends of the jejunum, preferably by side-to-side anastomosis, or, if this is not possible, an end-to-end union In the presence of obstruction of the pylorus by cicatricial contraction, close the opening in the stomach, excise the old gastroenterostomy and anastomose the proximal and distal ends of the jejunum and make either a Finney pyloroplasty or the ordinary gastroduodenostomy

In the absence of the pylorus, due to a prior pylorotomy or subtotal gastrectomy, a new gastroenterostomy must be made either in the usual way or by Roux-Y I now rarely make the latter, owing to the risk of another marginal ulcer forming, since the gastric juice flows directly into the distal limb of jejunum without being mixed with the bile and the pancreatic juice

It may be of interest to mention that I have one patient upon whom I have operated three times for marginal ulcer and who now, I feel quite sure, has a fourth one This is in keeping with what I have always maintained, that some individuals have an ulcer habit which it seems nothing will cure

EXPERIMENTAL INTESTINAL OBSTRUCTION*

A STUDY IN SEVERED GUT OBSTRUCTION AND SEGMENTAL OBSTRUCTION

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WHEN a number of investigators working at the same problem arrive at different conclusions, the confusion is at times ascribable to the fact that each one has worked out but a part of it. Moreover, the various findings may not have been properly interpreted and correlated, which of course often results in the presentation of divergent theories. As this would seem to be the case in connection with the experimental study of intestinal obstruction, the writer has attempted to approach the problem from this standpoint and correlate some of the widely contradictory views.

In the report here submitted, the writer has duplicated in part the work of others and also carried out a series of original experiments. Morphine-ether anæsthesia was employed in all of the operations.

In presenting the experimental data, it would seem expedient to arrange the subject matter into three groups, as follows:

Group I—*Severed Gut Obstruction*. Observation made to show the existence of a distinct duodenal obstruction entity in which the pancreas plays the dominant role (Draper,^{1, 12} Sweet, *et al* ²).

Group II—*Segmental Obstruction*. Observations made to show the existence of a distinct intoxication resulting from intestinal segments or loops (Roger,³ Whipple, *et al*,⁴ Murphy and Brooks,⁵ Dragstedt, *et al* ⁶).

Group III—An attempt to clear up certain points of discord between the various observers.

GROUP I—*Severed Gut Obstruction*. The first group of investigators produced an obstruction in the duodenum by simple severance and closure of the oral and aboral ends. Following this operation the animal has a few hours of normal existence and then rather suddenly develops a group of characteristic symptoms, namely, rapid pulse, vomiting, tremors, spasticity of the hind legs, and finally prostration and death occurs within a few days. This symptom-complex is, in the main, afebrile. Autopsy reveals (outside of the experimental obstruction) congestion of the viscera (liver, spleen and kidneys) with marked congestion of the mucosa of the terminal colon and to a less degree congestion of the gastric and duodenal mucosa.

Simple severance of the gut (Fig 1) and invagination of both ends,

* Read before the Clinical Society of St Bartholomew's Clinic and Hospital, New York City, December 22, 1920.

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if placed just aboral to the bile and pancreatic ducts,⁷ is followed by death in from thirty-six to ninety-six hours. When the obstruction is placed orally or aborally to this point (Figs 2, 3 and 4) the length of life

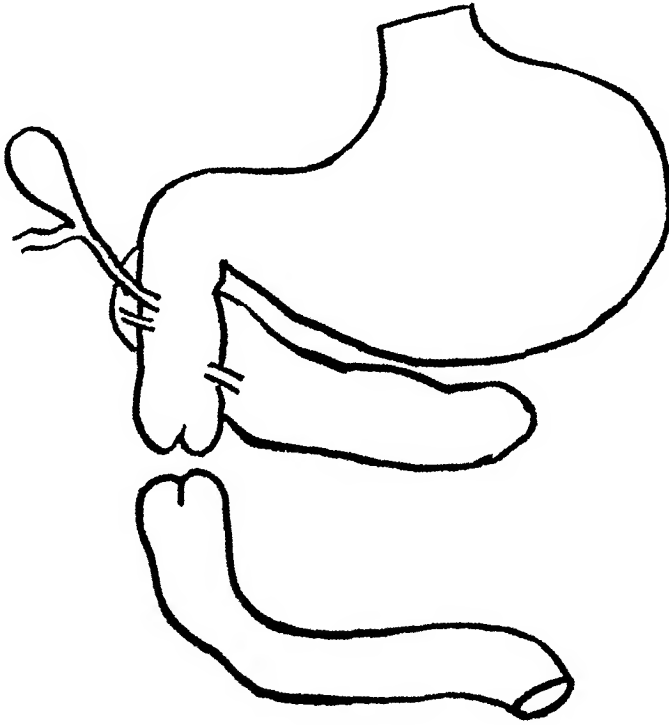


FIG 1

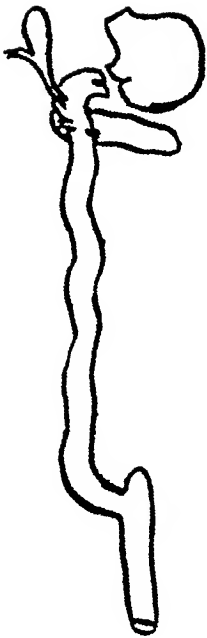


FIG 2

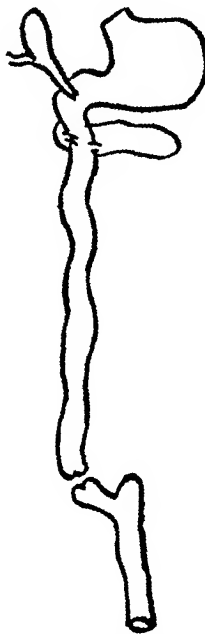


FIG 3

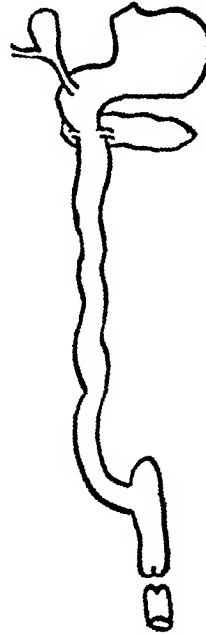


FIG 4

is increased and the attendant symptom-complex is changed.⁸ The small amount of necrotic tissue coincident with invagination of the gut cannot be held responsible for the death of the animal, on the ground that this factor remains the same irrespective of the location of the obstruction.

These experiments show that there is a point in the duodenum at which obstruction is more lethal than at any other point in the entire bowel

In a previous communication the writer and Doctor Draper⁸ reported the result of implanting the aboral end of a duodenal transplant with its outbuds, 15 cm in length (the oral end of which was occluded), into the ileum. At the same time the continuity of the canal was reestablished by a gastrojejunostomy (Fig 5). Subsequently a severed gut obstruction was made 35 cm from the gastrojejunostomy opening, *i e*, oral to the site of the transplant (Fig 6). In control animals a similar obstruction, also 35 cm from the pylorus, was fashioned without transplantation of the duodenum and its outbuds (Fig 7). The transplant animals lived seventeen days, the control animals lived six days. This

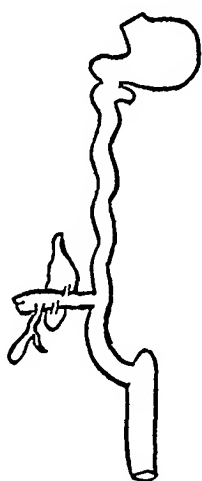


FIG 5

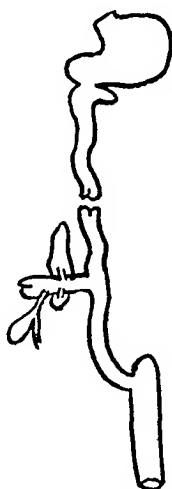


FIG 6

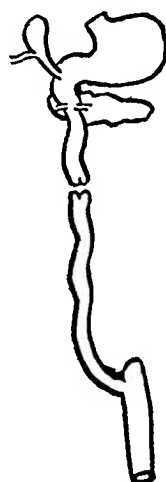


FIG 7

seventeen-day period of life is three days longer than that of an obstruction at the ileocecal sphincter (fourteen days) with the duodenum and its ducts left in their normal position. All fulminating toxic symptoms were absent in the transplant animals.

In the following experiments a 15 cm duodenal transplant with its oral and aboral ends occluded was employed. A gastrojejunostomy was performed to establish continuity of the gut (Fig 8). These animals died within twenty-four hours, the result of a partially distended devitalized transplant (segment). Death occurred before all the characteristic symptoms of high obstruction developed. Furthermore, if the oral end of this transplant was drained externally (Fig 9) the animal lived for several days without exhibiting any of the signs of obstruction.

In conjunction with these experiments it was demonstrated that animals in which the entire duodenal contents were drained externally lived as long as animals obstructed in the same portion of the gut, a similar condition of affairs obtained in connection with the jejunum. However,

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in both instances the attendant symptomatology was entirely different than occurred in the obstructed animals

PROTOCOLS OF CASES (SERIES OF 1920) NUMBER OF DOGS, 9*

Dog 126—Large male, brown and white Operation (Fig 8) Gastrojejunostomy Pyloric section—inversion oral and aboral ends, duodenal section 4 cm below bile and pancreatic ducts, inversion oral and aboral ends Marked

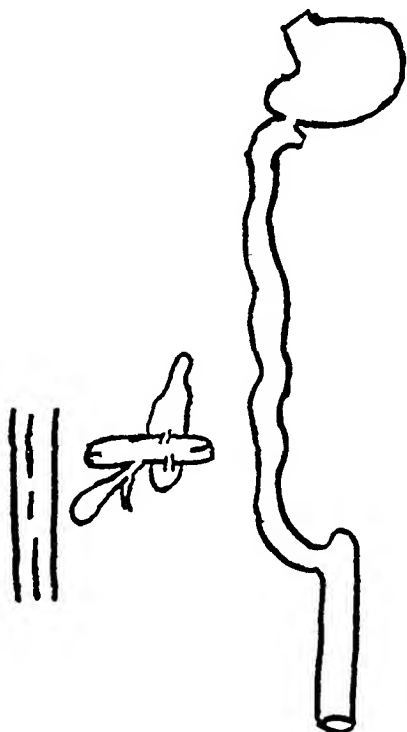


FIG 8

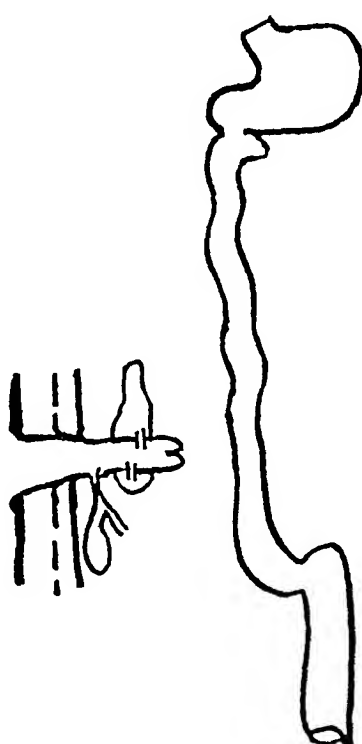


FIG 9

prostration followed by death within eighteen hours Autopsy Surgical pathology produced partially devitalized segment, free sero-sanguinous fluid in abdomen, no peritonitis, intestinal mucosa congested throughout

Dog 51—Small, brown male Operation (Fig 9) Gastrojejunostomy Pyloric section, inversion oral and aboral ends duodenal section 4 cm below pancreatic and bile ducts, oral end inverted, aboral end drawn through incision, sutured in place, left patent, animal died within seventy-eight hours No fulminating symptoms Post-mortem Skin excoriation, gastrojejunostomy opening was patent, omentum wrapped around transplant, slight congestion of peritoneum at site of wound, no congestion of intestinal mucosa

Dog 55—Medium, black and white, hairy female. Operation Duodenal drainage Duodenum severed below bile and pancreatic ducts, oral end inverted, aboral end drawn through incision and sutured in place Animal lived ninety-two hours No fulminating symptoms, gradual increasing weakness and death Post-mortem Marked skin excoriation, no congestion of intestinal mucosa, stomach markedly contracted

* The statement "number of dogs" placed after "Protocol of Cases" throughout this presentation, refers only to the number of dogs in which it was possible to record positive findings In each series of experiments a much larger number of dogs was used, many of these died of accidental complications and are for this reason not included in the number stated

HARRY BELLEVILLE EISBERG

Dog 109A—Small, white terrier, female Operation Jejunal drainage Jejunum severed 30 cm from duodenojejunal ligament, oral end inverted, aboral end drawn through skin incision and sutured in place Duration of life 186 hours Gradual weakness and death without fulminating symptoms Post-mortem Skin excoriated, stomach markedly contracted, slight peritoneal congestion at wound margin No congestion of intestinal mucosa

These experiments would seem to bear out the supposition that the duodenum with its outbuds produces the lethal toxins of high intestinal obstruction, that the gastro-toxins isolated by Roger⁹ do not produce a true picture of duodenal obstruction, and that the intestinal canal does

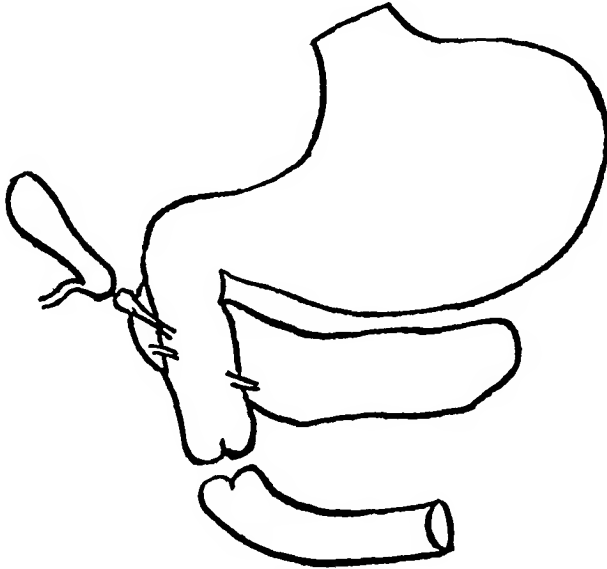


FIG 10

not produce a very marked toxæmia if the duodenum and its outbuds are transplanted into the gut below the obstruction

With regard to the toxicity of the bile in connection with severed gut obstruction, it was found that when the common bile-duct was ligated, the dog lived for several weeks. However, if the gut was obstructed below the entrance of the pancreatic ducts, and the common bile-duct was ligated with or without drainage of the gall-bladder (Figs 10 and 11), the animal died within thirty to ninety-six hours with the characteristic symptoms of high intestinal obstruction

PROTOCOLS OF CASES (SERIES OF 1918) NUMBER OF DOGS, 6

Dog 201—Small male, black and white Operation Common bile duct ligated Duration of life sixteen days Autopsy Gall-bladder distended, common duct found severed and ligated

Dog 214—Male, brown Operation (Fig 10) Common bile duct ligated Intestine obstructed below the pancreatic and bile ducts Symptoms characteristic of high

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intestinal obstruction Duration of life ninety-five hours Autopsy Gall-bladder distended, common duct ligated, liver congested (black); stomach somewhat dilated, congestion of gastric, duodenal and colon mucosa

Dog 206—Medium, female, brown and white Operation (Fig 11) Gall-

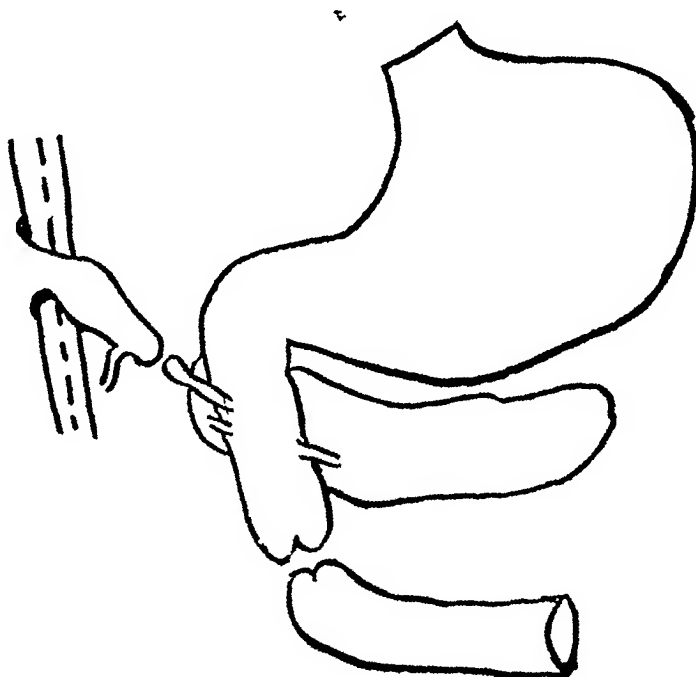


FIG 11

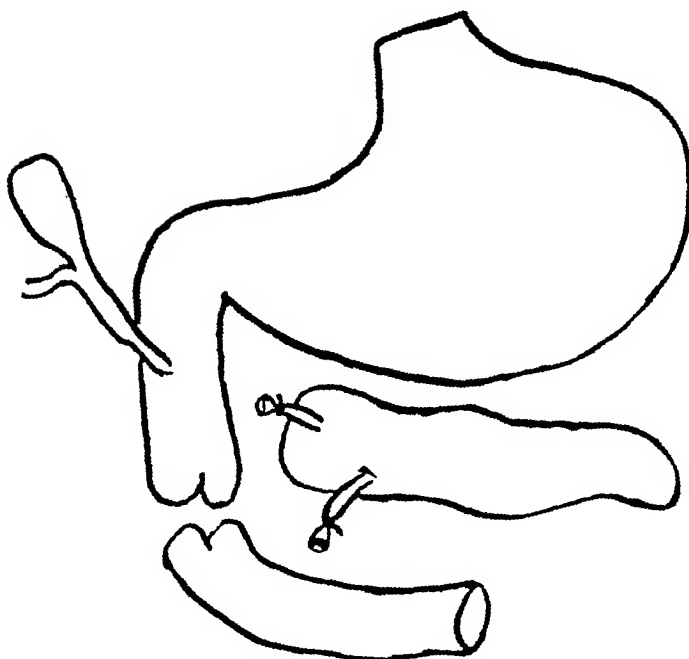


FIG 12

bladder drained externally, common duct ligated Intestine obstructed below pancreatic and bile ducts Duration of life sixty-five hours Symptoms those of intestinal obstruction Autopsy Surgical pathology produced, plus that obtained in severed gut obstruction

Meltzer and Salant¹⁰ have shown that the normal bile from many rabbits possesses an element which will produce chronic convulsions in frogs Roger¹¹ has also shown the toxicity of bile However, in these experiments this toxicity is a negative factor

These observations agree with those of Draper¹² who stated "It did not matter whether the bile emptied into the oral or aboral loop near the point of obstruction, whether the duct was simply ligated or cut or whether cholecystileostomy was done, the lethal outcome appeared rather conclusively still to be dependent entirely upon the position of the obstruction"

The influence of the pancreas in severed gut obstruction was studied by ligation of both pancreatic ducts with the duodenum (Fig 12) obstructed Some of these animals lived five to seven days In similar

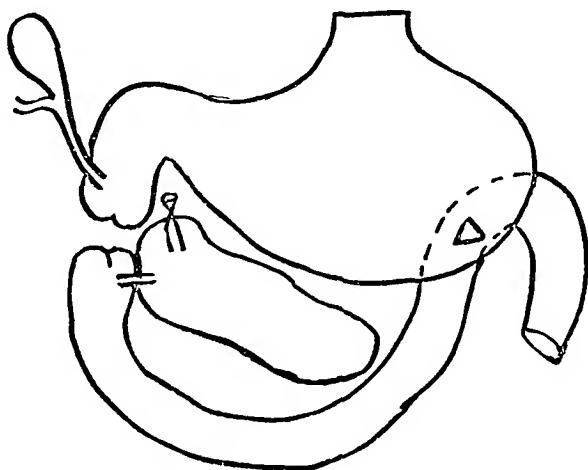


FIG 13a

experiments (Sweet, *et al*²) the animals lived seven to eight days None of these animals died with the symptoms of high intestinal obstruction

Draper¹³ performed this experiment somewhat differently, ligating the lesser pancreatic duct The gut was obstructed above the greater pancreatic duct in some cases, and in others below it A gastroenterostomy stoma control was added (Fig 13a and b) If the obstruction was placed oral to the duct the animals lived during the stoma control, which was seventy-two hours, if placed below, they died during stoma control

PROTOCOLS OF CASES (SERIES OF 1920) NUMBER OF DOGS, 3

Dog 130—Medium, male, brown and white Operation (Fig 12) Ducts ligated Obstruction placed below pancreatic and bile ducts Animal died 164 hours later without signs of high duodenal obstruction Autopsy Surgical pathology, very slight congestion of gastric and colon mucosa, omentum adherent to pancreas

In another set of experiments Sweet, *et al*,² isolated an ileal segment, restored the continuity of the gut, and, in some cases, filled the segment

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or loop with pancreatic juice, and in others with fresh dog's pancreas. A number of these animals died within the time limit of high intestinal obstruction with its characteristic symptoms. Roger and Garnier¹⁴ have demonstrated the toxicity of pancreatic juice, and also that this is increased when mixed with intestinal juice. Davis and Stone¹⁵ have shown that duodenal secretion from which the pancreatic juice is excluded is not toxic as long as it is kept from bacterial decomposition. Moorhead and Landes,¹⁶ Mann and Kawamura,¹⁷ as well as Dragstedt, *et al*,¹⁸ have demonstrated that duodenectomy is compatible with life and perfect health for short periods of time at least.

Our experiments and the observations recorded above suggest that the pancreas plays an important rôle in high severed gut obstruction.

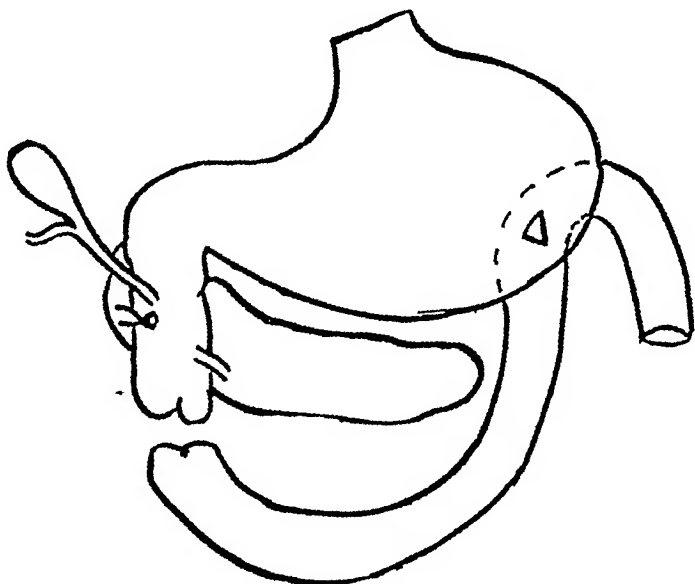


FIG 13b

This would also seem to show that the duodenal mucosa is not the determining toxic factor and that this membrane is not essential to life.

Sweet, *et al*,² states "the explanation of the similarity between acute pancreatitis and acute high obstruction—they are alike because they are both essentially the same thing, an intoxication with the toxic products of protein cleavage, in pancreatitis certainly due to proteolytic ferments of the pancreas, in high obstruction not necessarily, perhaps, but in our opinion in all probability, the same toxin, produced by the same ferment. In pancreatitis the escape of the products of digestion of the pancreas into the tissues permits the intoxication, in obstruction, the conditions of obstruction permit the absorption of the toxic products, which under normal conditions would either not be formed, or if formed would be immediately broken down to non-toxic products."

GROUP II—Segmental Obstruction The second group of investigators produced a doubly occluded segment or loop, in some cases using a gas-

troenterostomy to drain the duodenum, in others reconstructing the gut, while in still others the continuity of the gut was interrupted, a tape being employed to isolate a segment or loop

The life of the animal and the rapidity of the onset and the severity of the symptoms in this type of obstruction depend upon several factors the size of the segment, the condition of its circulation, whether this is partly or completely occluded, the location of the segment and the consequent variations in the digestive activity of the mucosal cells, and the bacterial content of the segment. Death results within from three hours to three days. The fatal outcome is preceded by listlessness, "grogginess," rapid pulse, vomiting and rise of temperature, the last may become subnormal. In the very toxic cases the animal at once becomes markedly prostrated and soon dies.

Necropsy shows the experimental lesion consisting of a segment of

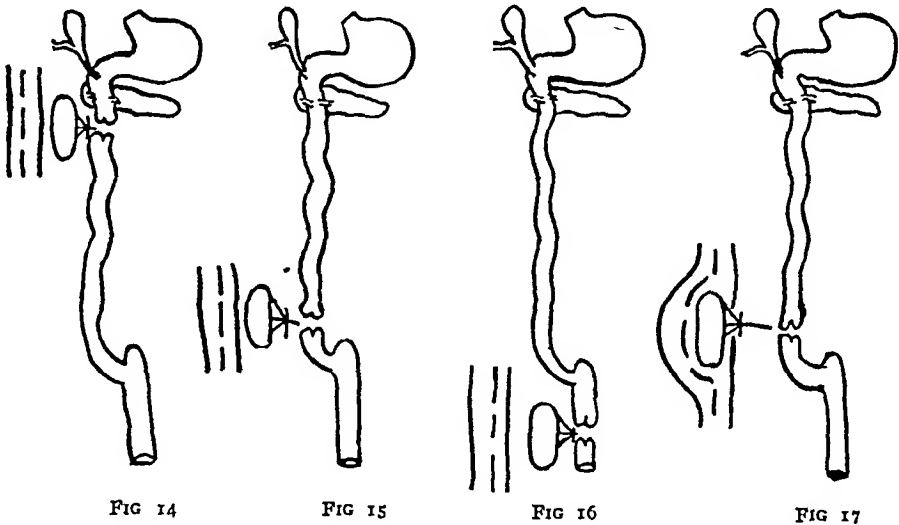


FIG 14

FIG 15

FIG 16

FIG 17

gut in different degrees of devitalization, free sero-sanguinous fluid in the peritoneal cavity, the engorgement of the liver, spleen and kidneys, congestion of the mucosa of the stomach, of the small intestine and, to a lesser degree, of the large intestine.

In the following series of experiments an excluded, bilaterally occluded segment about 20 cm. in length was used, the oral and aboral ends of the gut contiguous to the segment were inverted and closed. The circulation both to and from the segment was deligated, thus immediately devitalizing it. In each instance it was demonstrated that the experimental segment contained a colon-like bacillus. This exact procedure was carried out in the duodenojejunum (Fig 14), in the ileum, 8 cm. oral to the ileocecal sphincter (Fig 15), and in the colon region about 8 cm. oral to the anus (Fig 16). All these segments were left within the peritoneal cavity.

In other animals ileal segments were placed between the fascial planes

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of the abdominal wall (Fig 17), and in still others the segment was placed exterior to the skin (Fig 18).

All the animals died within seventy-two hours except those in which the segment was placed externally to the skin, in the latter event the segment had no effect on the health of the animal. Of the intraperitoneal segments, those fashioned from the duodenum were the most toxic, death occurring within twenty and one-half hours, those derived from the ileum were fatal in twenty-three to twenty-four hours, and those from the colon died in thirty-five to seventy-two hours. In the fascial segments located between the planes death occurred within twenty-six hours.

Since the dogs in Group II, just described, also had an associated severed gut obstruction (refer to Figs 14, 15, 16, 17 and 18) oral to the

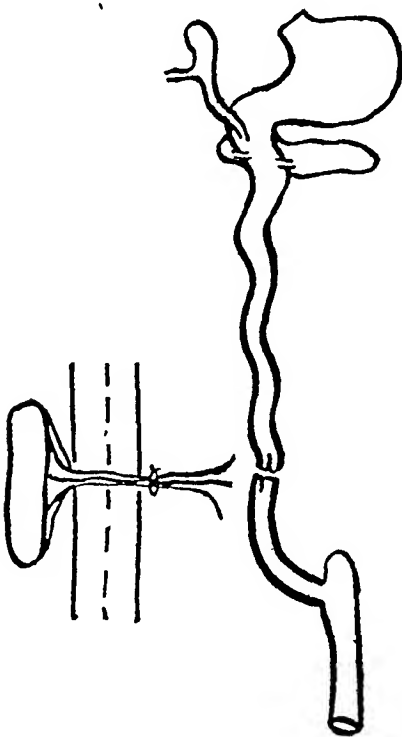


FIG 18

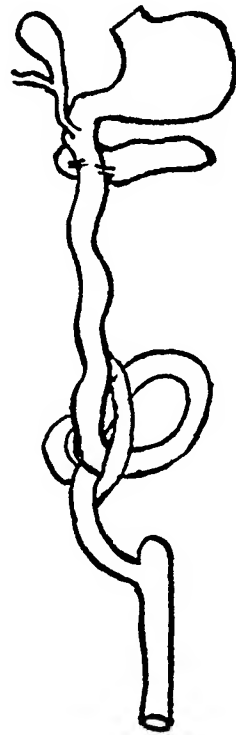


FIG 19

excluded segment, it is important to consider the significance of this in relation to the segmental type of obstruction.

None of these animals presented a typical picture of high severed gut obstruction, although the actual mechanical obstruction existed. The exception to this was noted when the obstruction existed in the duodenum (where the severed gut obstruction is most toxic), in which event some of the animals exhibited slight spasticity of the hind legs. It has been shown that in high severed gut obstruction most of the animals have a symptomless period of from eighteen to twenty-four hours in which they appear normal, while those animals with a devitalized segment become toxic and prostrated within this period and die within twenty-six hours, excepting when the segment is derived from the colon.

Excluding the confusing elements which arise in connection with a segmental obstruction in the duodenum where the two types are more or less associated, let us compare the length of life and symptoms of a simple severed obstruction in the ileum with those in connection with the isolation of an ileal segment. In the former instance the animal lives about fourteen days with signs of emaciation and gradual weakness until death intervenes and no fulminating symptoms develop, while in the latter instance (segmental obstruction) the animal dies within twenty-four hours with only a few hours of freedom from symptoms, this period is promptly followed by listlessness, unsteady gait (not spastic), marked weakness, and finally prostration and death.

When a severed gut obstruction is produced at the rectum the same picture develops as in the ileum, except that the animal lives twenty-eight days, while a segmental type of obstruction in this location is followed by death in from thirty-five to seventy-two hours. Hence, the ileal and rectal segments represent almost a pure type of segmental obstruction and present the same picture as though the continuity of the bowel were restored. Surely this would seem to show that the two types of obstruction are of a different nature.

In another series of animals segments 30 cm. to almost the whole length of the small intestine from the duodenojejunal ligament to the ileocecal sphincter were employed. These loops* were produced by knotting the gut itself (Fig 19), by simple twist of the gut (Fig 20), and by pulling a loop of gut through a rent in the mesocolon (Fig 21). In some of these cases the circulation was immediately occluded (knotting) and in others the circulatory nutrition was gradually interfered with by peristalsis and filling of the loop with its own secretion and transudate, and consequent distention.

In this series of observations the animals died within three to forty-two hours, with symptoms varying from marked prostration, from which the animal never recovered, to those observed in the segmental experiments just described. The length of life and severity of the symptoms in these loop cases apparently did not depend so much upon the size of the loop as upon interference with the blood supply to the loop and its location. In the large loops where the circulation was immediately cut off death occurred within from three to seven hours. In the instance in which the gut was drawn through the rent in the mesocolon with the gradual occlusion of the circulation, the animal lived forty-two hours despite the fact that the loop was 80 cm. in length.

In the following experiments a segment of gut in the duodenojejunum was isolated without deliberate interference with its circulation. In

* The term "segment" is used to denote an arrangement of gut as shown in Fig 15, the term "loop" is used to designate the condition of affairs shown in Fig 21.

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some cases the continuity of the gut was restored (Fig 24, a and b) In other cases the ends were inverted or a segment isolated with tape (Figs. 22, a and b, 23, a and b), whereupon a functional or severed gut obstruction was established above the point of isolation of the segment In the dogs in which the continuity of the gut was not reestablished and no

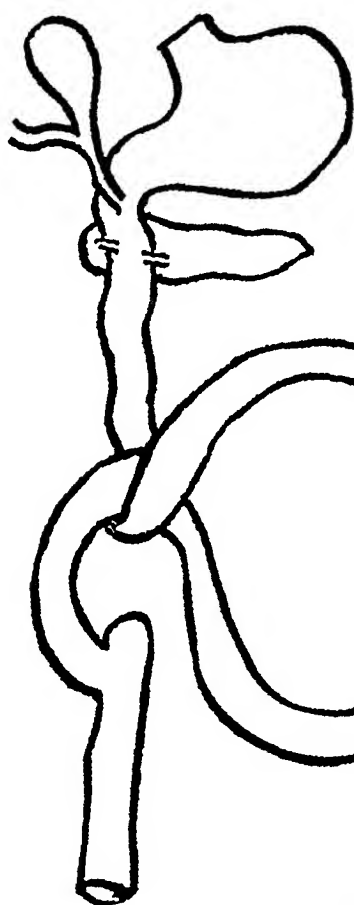


FIG 20

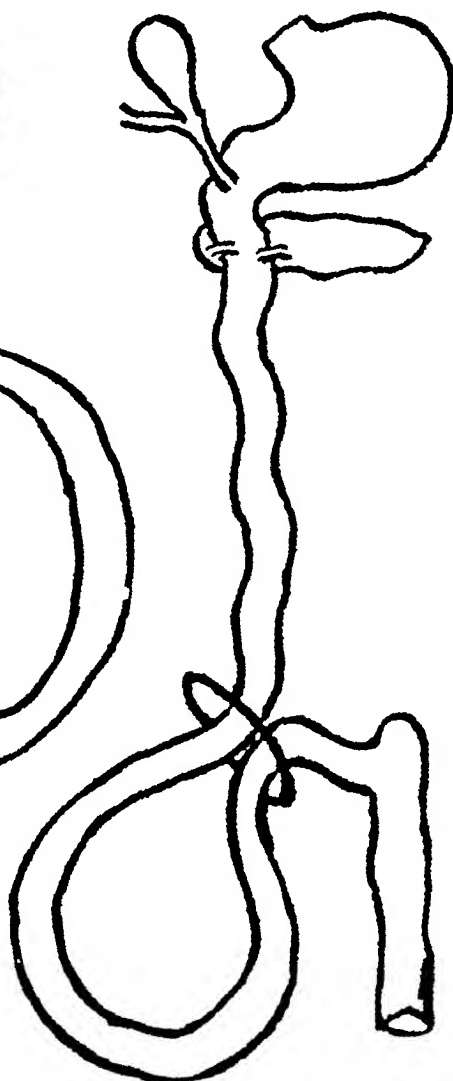


FIG 21

spontaneous distention of the segment occurred (Figs 22, a, and 23, a) death followed within sixty hours In those cases the segment appeared perfectly normal, showing no evidence of devitalization that is to say, the death of the animal was the outcome of the existing severed gut obstruction On the other hand, if under the same conditions the segment became spontaneously distended and later hemorrhagic in color, and finally devitalized (Figs 22b and 23b), death occurred within from twenty-four to thirty-six hours Here a combination of the severed

gut obstruction and segmental obstruction was responsible for the death of the animal, the latter (segmental obstruction) being the dominant one

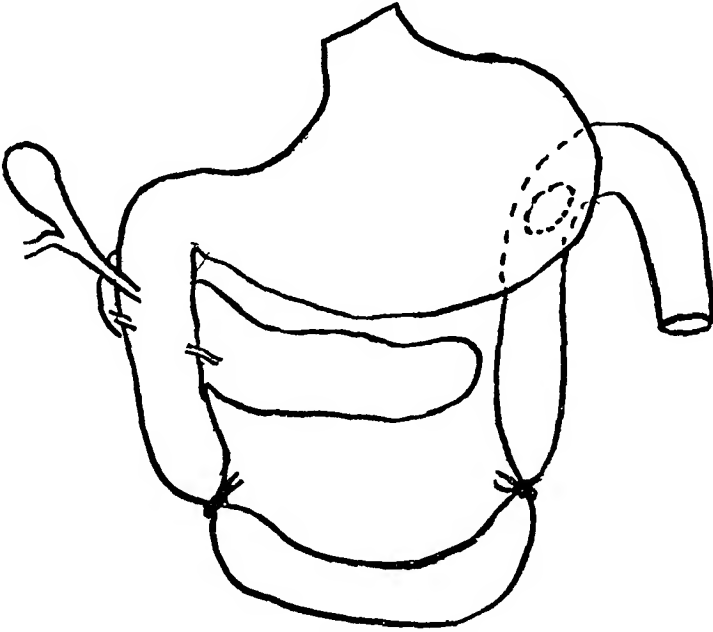


FIG 22a

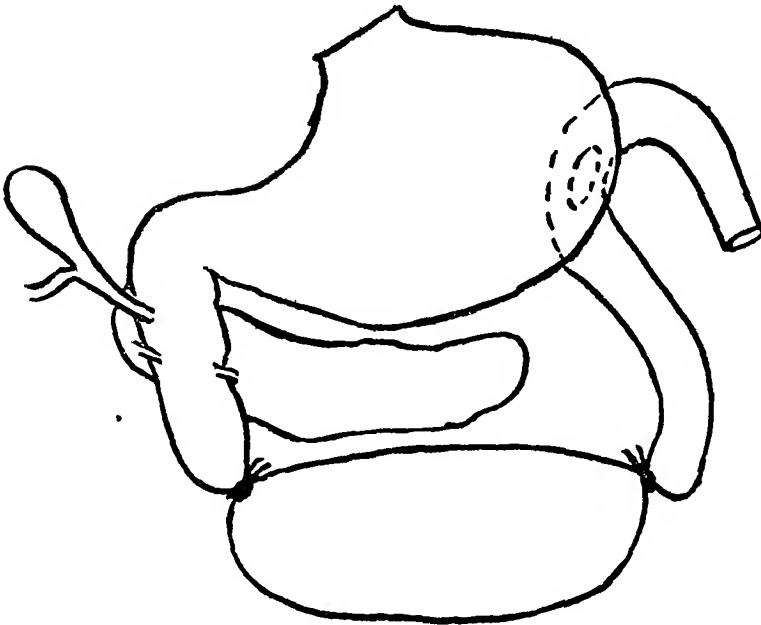


FIG 22b

In those cases in which reconstruction of the bowel was practiced (Fig 24, a) and no devitalization of the loop occurred, the animals lived several weeks. However, if the segment (Fig 24, b) became devital-

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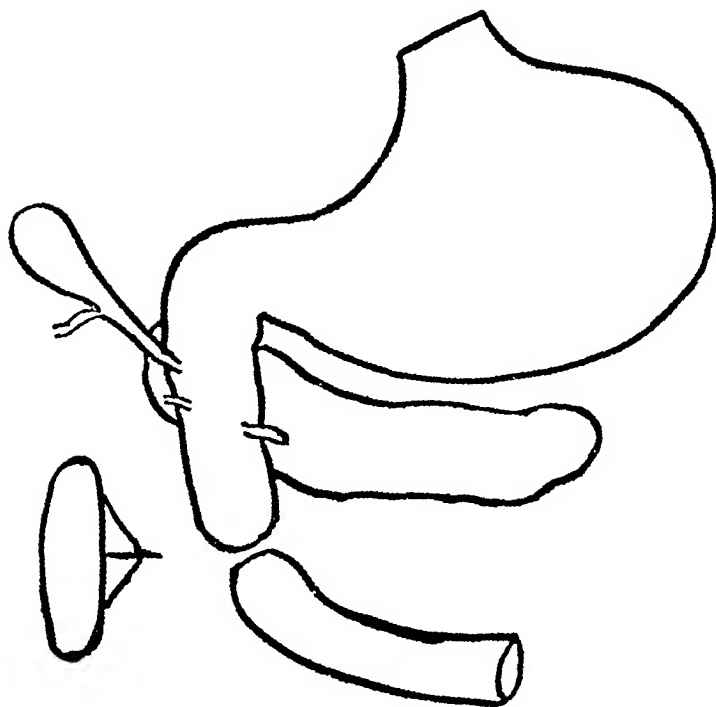


FIG 23a

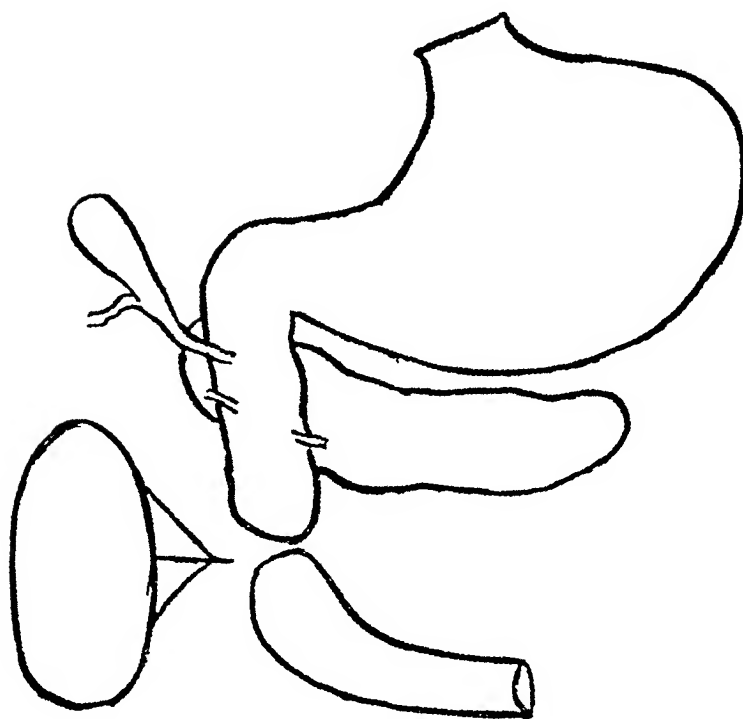


FIG 23b

ized and was not removed the animal died within forty-eight hours; the death in this case being due to causes arising in connection with the segment itself, as no severed gut obstruction existed above

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PROTOCOLS OF CASES (SERIES OF 1916, 1917, 1919, 1920) NUMBER OF DOGS, 35

Dog 108—Female, small, white terrier Operation (Fig 14) Duodenal devitalized segment Duration of life was twenty and one-half hours Autopsy

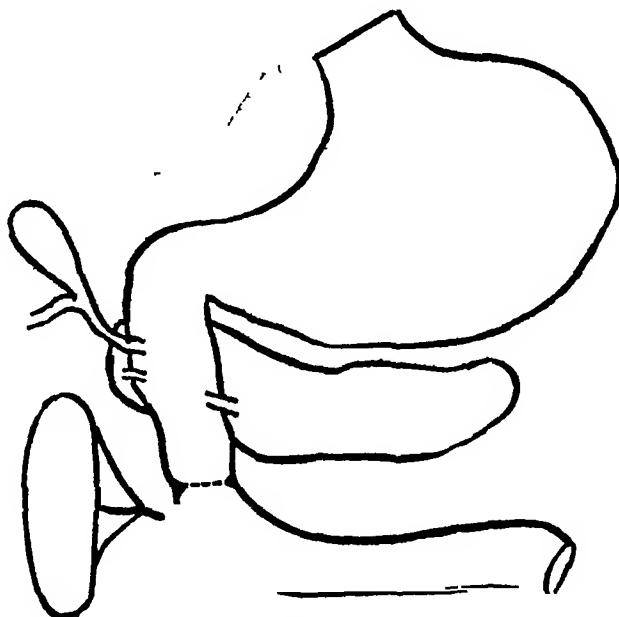


FIG 24a

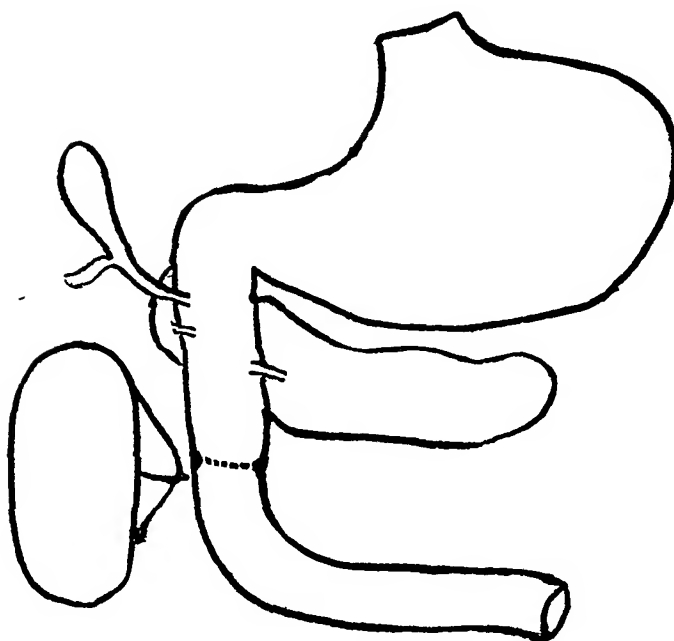


FIG 24b

Free sero-sanguinous in peritoneal cavity, 20 cm of devitalized partially distended segment, no reconstruction Congestion of intestinal mucosa small gut, slight congestion of colon, engorgement of liver and spleen

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Dog 106A—Male, small brown, short-haired Operation (Fig 15) Ileal devitalized segment. Duration of life was twenty-three hours Autopsy As in dog 108, with the following exceptions, Ileal segment employed instead of a duodenal segment, and that the intestinal congestion was not so marked

Dog 133—Female, medium, brown and white Operation (Fig 16) Colon devitalized segment Duration of life was seventy hours Autopsy Colon devitalized segment, some free fluid in peritoneal cavity, less than in other segments, congestion of intestinal canal was less than in small intestinal segments

Dog 87—Male, small, black and brown, short-haired Operation (Fig 17) Ileal devitalized segment placed under the skin between superficial and deep fascia Duration of life, twenty-six hours Autopsy No free fluid in abdominal cavity, slight congestion in parts of small intestines, none of duodenum or colon, abdominal parietes infiltrated with a sero-sanguinous fluid as occurs in the peritoneal cavity containing a devitalized segment, a segment was found in the fascial planes, from which a colon-like bacillus and a staphylococcus were isolated The latter was probably a contamination

Dog 109A—Female, small white terrier Operation (Fig 18) Ileal segment exterior to skin, segment removed twenty-four hours later, gut reconstructed, no toxic symptoms developed Animal made an uneventful recovery

Dog 86—Male, small, brown, short-haired Operation (Fig 19) Ileal loop 50 cm in length knotted Duration of life, ten to twelve hours Autopsy Surgical pathology produced (50 cm devitalized loop), free sero-sanguinous fluid in peritoneal cavity Marked congestion of stomach, duodenum, small intestine and colon

Dog 101—Male, medium, brindle mongrel Operation (Fig 20) Entire small gut accidentally twisted while forming an ileal segment Duration of life three hours and three minutes Autopsy Gut twisted from duodenojejunal ligament to terminal ileum, marked dilatation and congestion, ileal segment devitalized, colon showed a slight congestion, free sero-sanguinous fluid in peritoneal cavity

Dog 88—Male, large, short-haired bull terrier Operation (Fig 21) Ileal segment removed (previous operation) and a rent in mesentery produced through which 80 cm of small gut slid Duration of life, forty-two hours Autopsy 80 cm. strangulated small intestine, gradual devitalization which accounts for the longer duration of life, free fluid in peritoneal cavity, slight congestion of the rest of the small intestine and slight congestion of colon

Dog 53—Male, small, brown and white terrier Operation Jejunal ileal segment 96 cm in length, circulation ligated Duration of life, six hours Autopsy 96 cm. partially distended, devitalized segment, free fluid in peritoneal cavity, congestion of small gut and colon

Dog 256—Female, medium, brown and white Operation (Fig 22, a) Duodenojejunal segment 40 cm. in length, tape used to isolate segment, no interference to the circulation, posterior gastrojejunostomy Duration of life, ninety hours Symptoms of severed gut obstruction Autopsy No free fluid in peritoneal cavity, surgical pathology produced, segment not distended nor discolored, contained small amount of whitish pasty substance Gastric, duodenal and terminal colon mucosa congested

Dog 240—Male, small, brown Operation (Fig 22, b) Segment 40 cm in length, tape used to isolate segment; no interference to the circulation, posterior gastrojejunostomy Duration of life, seventy-four hours Symptoms of severed

gut and segmental obstruction Autopsy Surgical pathology produced, segment black in color, markedly distended, congestion of gastric mucosa, small and large intestinal mucosa, free fluid in peritoneal cavity

Dog 303—Male, large, white Operation (Fig 23, a) Segment 40 cm in length, no interference to the circulation, no reconstruction of the gut. Symptoms of severed gut obstruction Duration of life, forty-eight hours Autopsy Surgical pathology produced, no distention of segment, no free fluid in peritoneal cavity, congestion of duodenal, gastric and colon mucosa

Dog 309—Male, large, black. Operation (Fig 23, b) Segment 30 cm in length, no interference to the circulation, no reconstruction of the gut Duration of life, thirty-six hours Symptoms of severed gut and segmental obstruction Autopsy Surgical pathology produced, segment distended, dark hemorrhagic in color, free fluid in peritoneal cavity, no observation on congestion of intestinal mucosa made

Dog 291—Female, medium, black and white Operation (Fig 24, a) Jejunal segment 40 cm in length, no interference to the circulation, reconstruction of bowel, end-to-end anastomosis Dog made an uneventful recovery Two weeks later, dog sacrificed, chloroform anesthesia, blood removed for chemical study Autopsy Segments normal in appearance, not distended, omentum wrapped around segments, anastomosis in good condition, no intestinal congestion

Dog 278—Female, large, black and white Operation (Fig 24, b) Duodenojejunal segment 50 cm in length, no interference to circulation, reconstruction of bowel, lateral anastomosis Symptoms of segmental obstruction Duration of life, fifty-six hours Autopsy Surgical pathology produced, segment distended, free fluid in peritoneal cavity, slight congestion gastric, small and large intestine mucosa

These experiments definitely show that the changes in isolated devitalized segments are responsible for the lethal outcome

In some instances when duodenojejunal segments were isolated and the circulation was not interfered with and the continuity of the gut restored, the segments did not distend nor become devitalized and the animals did not develop untoward symptoms, while, on the other hand, in a certain number of animals in which the conditions were in every regard similar to those just stated, the segment did become distended and devitalized and the animals presented the picture of segmental obstruction and soon died When the same conditions were produced in the ileum and colon, the result in by far the greater number of cases was similar to what occurred in the duodenojejunum when no devitalization was present

The reason why isolated segments (continuity of the gut restored) of the small intestine, especially those located in the duodenojejunum, frequently distend and become devitalized even though the circulation is not deliberately interfered with, whereas those in the colon become distended but not devitalized, is because of the preponderance of the secretory over the absorption phase in the small intestine, while the reverse obtains in the colon Attention was called to this fact by Obalinski¹⁹ Although the colon segments were practically empty at the

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time of their isolation, they later became filled with material, much distended and the intestinal wall hypertrophied. This was observed by Blake and Brown²⁰. However, in the small intestinal segments the secretion appeared more rapidly and the distention interfered with the circulation before a compensatory state had time to develop.

This explanation cannot be applied to those instances in which the isolated duodenojejunal segment does not become devitalized, for the reason that were interference with the circulation necessarily the outcome of the domination of the secretory phase and consequent distention and devitalization, this would occur in every instance, while such is not the case. Therefore, it is necessary to search for another factor as causative in this connection.

It is suggested that the greater motility of an isolated segment of small intestine renders it more responsive to peristalsis, and thus a comparatively slight torsion of its mesenteric attachment may partially interfere with the circulation (circulatory stasis), and this in turn becomes responsible for a rapid filling of the segment with a bloody transudate and intestinal secretion. If this be true, the conditions may be regarded as important factors in the devitalization of isolated segment in which there has not been a deliberate interference with the circulation.

This conception (based on the observation in Groups I and II) argues that bacteria are not the all-important factor in the cause of death in experimental obstruction. Certainly in the severed gut type they appear to play no part, the only pabulum is the devitalized tissue at the site of inversion, and if this small amount of necrotic tissue were sufficient to cause death the symptom-complex of obstruction in the duodenum and colon regions would be the same. Instead of this, there is a difference of about twenty days between colon and duodenum (severed gut obstruction) in duration of life.

In the second group of observations, the segmental obstruction is compatible with life if the continuity of the gut be restored and if there is no devitalization of tissue, although bacteria are present in the segment.

However, when devitalization of tissue occurs there is a pabulum for bacteria and the production of toxic substances must follow.

When death occurs early (three to seven hours) after a large loop or segment has been isolated and its circulation abolished, one must search for some other cause for death than the action of bacteria upon devitalized tissue. It is, therefore, submitted that the specialization of the digestive cell, which is greatest in the duodenojejunum, is the foremost lethal factor, while the action of bacteria is a secondary one in segments devitalized by immediate interference with the circulation. However, it is not improbable that in gradually devitalized segments (the outcome of distention and circulatory stasis) bacterial action is the important pernicious factor because of the period of incubation thus presented.

From an experimental standpoint, putrefaction, the outcome of bac-

terial action upon nitrogenous foodstuffs, may be disregarded on the ground that the entire complex stated above may obtain in fasting animals. The toxicity of segmental obstruction may be increased if food is present in the segment, but this may be regarded as a minor factor. This view is supported by the fact that a simple severed gut obstruction at the rectum permits the animal weeks of life without the appearance of fulminating symptoms, and surely putrefaction must be very active under these conditions.

To summarize with regard to Group II (segmental obstruction) The evidence at hand suggests that the toxic products of protein cleavage may be a primary cause of death and that these cleavage products are the result of proteolytic action on somatic cells the death of which is the outcome of interference with their blood supply. The action of bacteria on devitalized tissue is no doubt of secondary importance. However, they must become a prominent factor when the circulation is gradually occluded. As the investigation of the activities of intestinal anaerobic bacteria is still without definite result, the future may show that bacteria are more of a factor in segmental obstruction than now seems to be the case.

GROUP III—An attempt to clear up certain points of discord between the various observers.

Of the many observers working with intestinal segments or loops almost all, except Draper⁸ and Sweet² and his co-workers, have disregarded the importance of the simultaneous presence of the severed gut obstruction (functional obstruction) oral to the isolated segment. To Sweet² belongs the credit of demonstrating the importance of the pancreas in simple severed gut obstruction.

Roger²¹ was one of the early observers to study this intricate problem of intestinal obstruction from a chemical and toxicological standpoint. He and his associates, notably Garnier, isolated the toxins (including toxic proteoses) from the different portions of the intestinal canal. They studied the toxicity of the stomach contents, of the bile, and of the pancreatic juice. They demonstrated that the toxins derived from the intestinal mucosa are more toxic than those extracted from the contents of the gut, and that the duodenal mucosa possesses a greater toxicity than that of the ileum. Their bacteriological studies encompassed the aerobic and the anaerobic groups.

Viewing the experimental work just mentioned as a whole, one gets the impression that the isolation of a single lethal, toxic agent in both the types of obstruction under consideration is impossible, and that a number of substances must be taken into account in animals whose condition is normal except for the experimental obstruction. While this may be true, our experimental work seems to establish a relative lethal importance as far as these various factors are concerned.

Whipple⁴ and his co-workers studied the loop or segmental type of

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obstruction, and their isolation of a toxic proteose was considered the lethal agent. That this proteose is composed of one or more primary proteoses and perhaps some B-nucleoprotein and nucleohiston is a later view toward which Whipple²² seems to lean.

However, Whipple's contention that the toxæmia is the outcome of a perversion of secretion or of a pernicious activity of the mucosa is difficult to understand, unless one assumes that the perversion of secretion may be the result of circulatory disturbances despite the fact that the blood supply of the segment is not deliberately interfered with. This

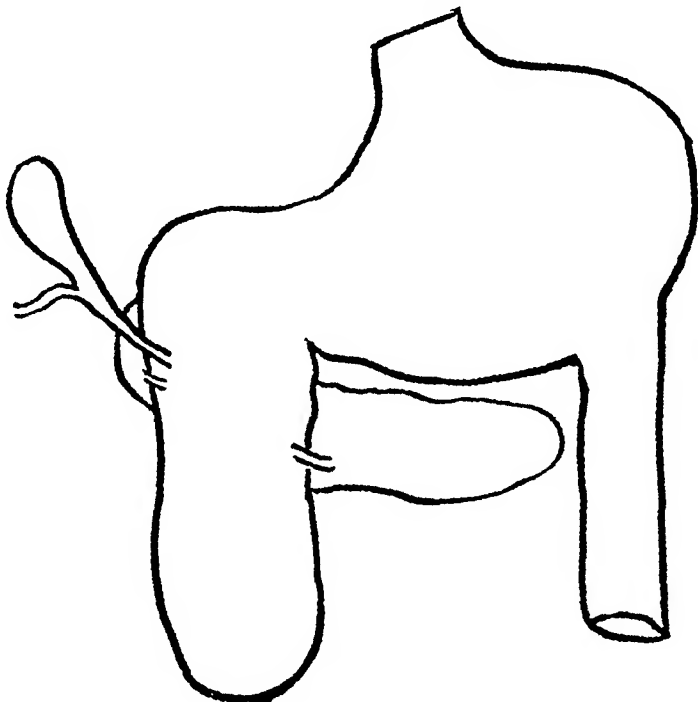


FIG 25

is borne out by the observation that the presence of segments in which no circulatory changes have occurred is compatible with life provided the continuity of the gut is restored.

With regard to the experiments of Whipple, *et al*,⁴ in which the animals died, and autopsy showed only the loop of intestine which contained a certain amount of pasty material and no histological evidence of injury to the mucosa, Sweet, *et al*,² called attention to the fact that in these animals a functional obstruction (severed gut type) existed oral to the segment (Fig 22, a) and that the simultaneous presence of a gastroenterostomy did not necessarily drain the duodenum above the obstruction. Sweet and his co-workers proved this experimentally. That is, they showed that the duodenum was drained by a gastroenterostomy only when the duodenum dilated and became hypertrophied (Fig 25), under these conditions the animal survived. On the other hand, if the duodenum did not undergo the changes stated above, the gastroenterostomy was not effective as an oral drain (Fig 26) and the animal died.

A similar explanation of the fatal outcome is applicable to the experiments (Fig 27) of Whipple, *et al*, in which, although the segment was drained externally and even freely washed out, the animals died because the oral gut was not drained by the gastroenterostomy. In addition to this, Sweet and his coworkers further proved the rationale of their contention when they isolated a segment of the duodenum (similar to that of Whipple, *et al*) but restored the continuity of the gut and at the same

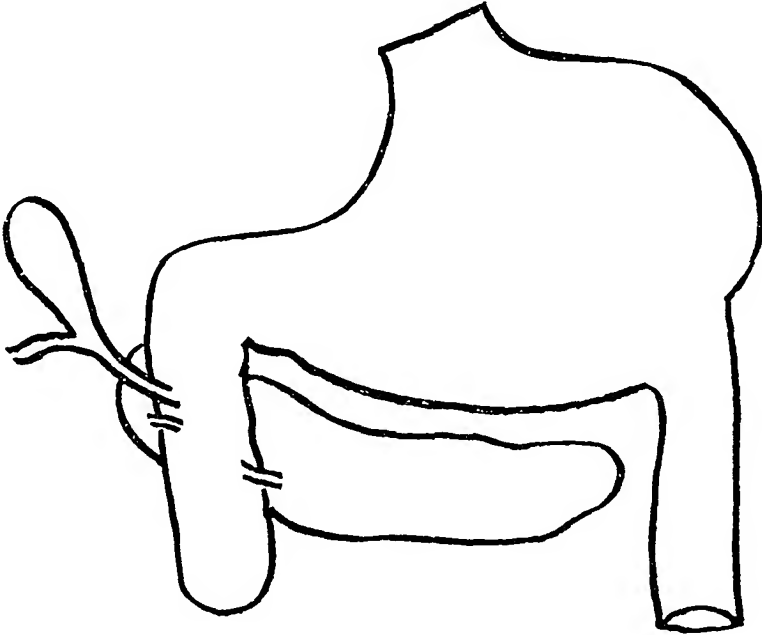


FIG 26

time demonstrated that when either end of the isolated segment was drained the animal remained normal. This operation really consists in establishing a Thiry-Vella fistula (unilateral occluded segment).

Draper,⁷ after experimenting with Thiry-Vella fistulae, observed that at the end of four or five days the animals showed marked evidence of toxæmia, rapidly lost weight and died within a short period of time. However, when the mucosa was removed from the isolated segment none of the symptoms stated developed. These findings would seem to accord with those of Whipple, *et al*.

The observations of the writer in connection with Thiry-Vella fistula would seem to justify acceptance of the views of Sweet.

PROTOCOLS OF EXPERIMENTS (SERIES OF 1916-1917) NUMBER OF DOGS, 3

Dog 167—Female, small fox terrier. Operation March 12, 1917, Thiry-Vella fistula. Animal died June 17, 1917. Duration of life, ninety-seven days. No fulminating toxic symptoms developed. Animal became gradually emaciated. Autopsy. Negative as to actual cause of death.

In this series of experiments death occurred rapidly in three instances, the fatal outcome, however, was due to the presence of a de-

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vitalized segment (unilateral occlusion), to peritonitis and to a pancreatic abscess and was not the result of a toxæmia sequential to the absorption from the duodenal segment (unilateral occlusion)

Certainly if a toxæmia is produced it is not a pernicious factor as compared to the effects of either of the obstructions under consideration. The rapid death in Whipple's experiment (Fig 27) must be

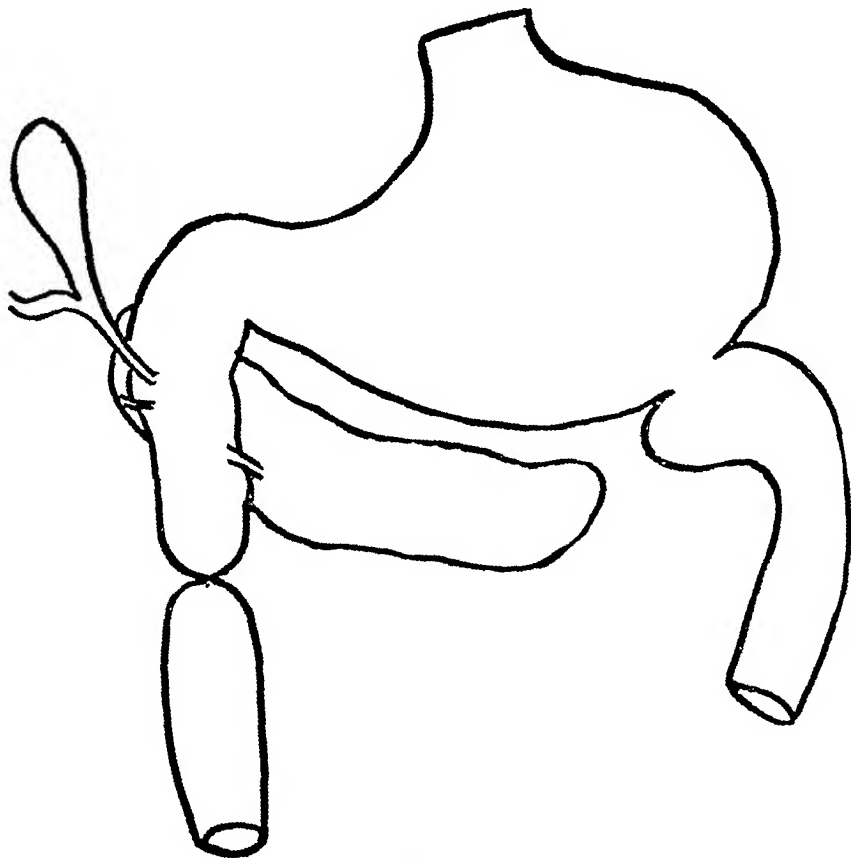


FIG 27

attributed, as Sweet suggested, to the oral functional obstruction (severed gut obstruction).

The view advanced by Sweet, *et al*,² which Draper³ and his associates at one time were inclined to accept, that when a segmental obstruction was fashioned, the proteose of Whipple was formed in the gut above (Figs 22, b, 23, b) the point of obstruction and excreted into this segment, cannot be reconciled to the fact that in the presence of a segmental obstruction in which the continuity of the gut was restored (Fig 24, b) and the animal died. However, if the isolated segment was not devitalized (Fig 24, a) the animal lived. This argues that the lethal toxin is formed in the segment and is not the result of the oral obstruction, for the reason that the obstruction element is removed from the problem by restoration of the continuity of the gut. This is one of the determining considerations in support of the belief that Whipple's entity is not the outcome of an oral functional obstruction.

The fact previously reported,⁸ into which the contents of isolated segments (with reconstruction of the continuity of the gut) was injected showed only slight or no evidence of intoxication, can only be explained on the ground that we committed a technical error in the isolation of the poison. Our conception at that time was that since no functional obstruction existed above the segment, no poison was formed. However, since this time we have on frequent occasions isolated a proteose under the very conditions under which we previously failed.

As to the character of the proteose from a chemical standpoint, it would seem that the poison consists of several further split products. This is supported by the fact that in chemistry a proteose is not regarded as toxic. This does not, however, exclude the conception that the intoxication may be dependent upon the product of further cleavage of the protein molecule. In any event, one must bear in mind that the intravenous injection of the poison or poisons is followed not by the signs of high severed gut, but of segmental gut obstruction.

PROTOCOLS OF CASES (SERIES OF 1916-1917) NUMBER OF DOGS, 10

Dog 221—Female brindle, 6 kilos 6/8/17—Ether anaesthesia 8 40 P M Kymograph observation throughout experiment 8 45 P M—Blood pressure normal Injection of 35 c c purified loop fluid (lethal dose) Primary rise of blood pressure—duration ten minutes 9 50 P M—Pulse, 120, slight fall in pressure 9 58—Temperature, 100 10 00—Pulse, 114, semi-solid stool Pressure normal 10 25—Semi-solid stool 10 45—Pulse 126, irregular diarrhoea Pressure normal 10 50—Temperature, 98 11 15—Small semi-solid stool 11 30—Respiration, 14, temperature, 94, pulse, 104, irregular 11 45—Small semi-solid stool 12 15—Bloody stool 1 00 A M—Bloody stool Temperature, 96, respiration, 16, pulse, 62, slight fall in pressure 1 45—Bloody stool 2 40—Temperature, 96.5, respiration, 20, pulse, 100, irregular Still farther fall in blood pressure Bloody stool 3 30—Pulse imperceptible, profound prostration Marked fall in blood pressure 5 10—Animal dead 5 30—Autopsy Slight congestion of liver, spleen, and more or less throughout the stomach and intestinal mucosa Colon contents blood tinged

Dog 222—Male, black and white 6 kilos 6/8/17—Ether anaesthesia 9 30 P M, pulse, 100 9 35—Intravenous injection 130 c c purified loop fluid (lethal dose) Compare with dog 221 9 40—Pulse, 36, respiration, 18 Dog still under influence of ether 10 00—Dog responds to whistle and call, staggers around 10 10—Pulse, 60 10 30—Animal became prostrate Pulse, 186, temperature, 98 10 55—Liquid and semi-solid stools Profound prostration 11 05—Diarrhoea Animal attempts to walk around, urinates 11 15—Bloody stools (diarrhoea) Prostration less 11 35—Pulse, 132, respiration, 18, temperature, 97 Small watery stool 11 50—Dog very weak, falls to floor when placed on feet Small bloody stool 12 40—Watery stool Marked prostration 1 00 A M—Diarrhoea Pulse, 160, respiration, 15 Marked prostration 1 30—Dog cold 2 00—Pulse, 120 2 10—Pulse, 150 2 15—Pulse, 220 2 20—Animal dead Duration of life four hours and fifty minutes 3 00—Autopsy Same as dog 221, except for marked engorgement of liver and spleen The congestion of stomach and intestine was much greater Dog did not vomit.

Dog 223—Male, large, brown 10 45 P M—Ether anaesthesia Preoperative pulse, 72, respiration, 25, temperature, 101 10 50—Injection 115 c c mucosa extract de albuminized After anaesthesia slight diarrhoea No prostration Animal recovered at once from anaesthesia and ran around 11 00—Pulse, 186 11 15—

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Resting 11 40—Pulse, 72, respiration, 44, temperature, 99 Animal showed slight weakness 1 00 A M—Pulse, 60, respiration, 26, temperature, 100 Weakness of hind legs 1 30—Watery stool, no blood 2 05—Hind legs still weaker 2 30—Hind legs much stronger 3 00—Pulse, 60, respiration, 26, temperature, 100 Dog in good condition 3 10—Dog in good condition

Murphy and Brooks⁵ suggested that in intestinal obstruction the presence of necrosis of the gut, together with the action of bacteria, were the important causative factors in the toxæmia attendant upon this condition.

Dragstedt⁶ and his associates, working along similar lines, were inclined to regard bacterial action as the dominant factor in the production of the toxæmia. They claim that the presence of sterile devitalized loops is compatible with life.

The fact that the presence of sterile devitalized segments of gut is not followed by death, does not answer the contention on part of the writer that duodenal segments are more toxic than those fashioned in the colon, nor does it make less true the fact that the isolation of large devitalized segments is rapidly fatal. The writer feels that though an abacterial segment is isolated in the abdominal cavity of the experimental animal, it is still capable of causing death because of liberation of a toxin the result of the breaking down of the host protein. This would explain why a duodenal segment is more toxic than one of the colon, on the ground that the digestive specialization of the cells of the mucosa is greater in the duodenum than it is in the colon, it also explains the rapid death when large devitalized segments are obstructed, as this means destruction of a greater area of cells. One of the possible fallacies of the explanation just offered might be developed in connection with further investigation of the action of anaerobic bacteria and their symbiosis with the aërobes acting on devitalized tissue. In this event, however, one would have to assume a degree of virulence on part of this combination of bacterial life not as yet demonstrated.

Further support of the non-bacterial character of the intoxication in segmental obstruction is supplied by Cooke and Whipple,²³ who produced a sterile abscess by means of turpentine injections, and acute pancreatitis by the injection of sterile bile. The advent of these conditions was followed by an intoxication very similar to that following an injection of a toxic proteose.

In investigating along these lines, the writer scraped out the mucosa of an isolated duodenal segment, thoroughly washed it and introduced the washed scrapings into the peritoneal sac of a normal dog. Following this one of three things happened. No reaction occurred, peritonitis developed, or the animal exhibited tremor, bloody stools, vomiting and rise of temperature, *i e*, a non-lethal picture of a proteose intoxication, such as follows intravenous injection, was provoked. Hence, it would seem permissible to assume that we produced a condition of affairs which was in no sense ascribable to bacterial action.

PROTOCOL OF CASES (SERIES OF 1916-1917) NUMBER OF DOGS, 6

Dog 163—Male, medium, 30 cm caudad duodenum resected, end-to-end anastomosis Duodenal mucosa washed thoroughly, mucosa scraped and introduced into the peritoneal cavity (homologous cells) Within thirty-six hours the dog passed bloody stools, apparent tenesmus, vomited once Temperature, 102, pulse, 156 Urinary output increased and dog very thirsty on the following day, blood and mucus passed Temperature, 102, pulse, 114, irregular Slight tremors, no vomiting Twenty-four hours later the dog made an uneventful recovery Two weeks later the washed cells from an obstructed dog were introduced into the peritoneal cavity (Dog No 163) Dog made an uneventful recovery without signs of obstruction One week later washed cells from another obstructed dog were introduced into the peritoneal cavity (Dog No 163) The dog died twenty-four hours later Autopsy revealed a frank peritonitis

The theory of Draper,⁷ that in severed gut obstruction the administration of the scrapings of jejunal mucosa suspended in water detoxicated the poison originating in the duodenal mucosa, is now regarded as fallacious, and it would seem that the beneficial effects produced may be properly ascribed to the watery contents of the mixture employed and not to any specific effect on the part of the jejunal scrapings Hartwell and Hoguet²⁴ increased the duration of life in their obstructed animals by the copious administration of water Their point of view that dehydration of tissue is the important factor with a secondary intoxication the result of dehydration, as the cause of death in severed gut obstruction, does not appear to be in accord with present views

COMMENT AND SUMMARY

In the types of experimental intestinal obstruction discussed above, the toxins seem to have a two-fold origin In severed gut obstruction in the duodenal region the pancreas is probably the main source of the toxin Bacteria are apparently not a determining factor in this type of obstruction

In the pure segmental type of obstruction (*i e*, an isolated segment with the continuity of the gut restored) the damaged intestinal tissue is the deciding factor as regards lethal outcome, if no devitalized tissue is present death does not occur In non-devitalized segments bacteria alone will not be responsible for a lethal outcome Surely at times a devitalized segment appears to be responsible for a lethal outcome long before there has been time for bacterial action to play a part in the result When a severed gut and segmental obstruction are present together and there is no damage to the intestinal mucosa in the segment, the lethal outcome is due to the oral severed gut obstruction and not to the undamaged segments

In both types of obstruction the breaking down of the host protein molecule appears to be an important factor in the formation of toxic substances Whether the actual end products in both instances are chemically allied or not has yet to be proven

In the severed gut obstruction death appears to be essentially a

physiological one. In the devitalized segmental type this is true in the main, the added element being the presence of bacteria.

For the present the character of the toxic product in the former can only be conjectured, while in the latter the not clearly defined proteose or its split products may be regarded as the lethal agent.

In conclusion the writer wishes to express his thanks to Prof. George D. Stewart for the courtesy of the research laboratory. For the constructive criticism of this paper, the generous help of Professor Haubold and Doctor Draper was obtained. Professor Gettler gave his valuable assistance in elucidation of the chemistry of the problem. To Doctors Barber, Vejvoda, Stark and Otto the writer is indebted for their able assistance in the surgical procedures carried out in these experiments.

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A FUNDAMENTALLY NEW TECHNIC FOR INGUINAL HERNIOTOMY *

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OF ST LOUIS

THIS addition to the stream of discussion of inguinal herniotomy technics shows that I agree with those who feel that our statistics in this operation are materially better than our results. Further, that through a thorough study of the underlying anatomy, physiology and pathology, I am hopeful of having been able to grasp some hitherto not properly evaluated principles. My previous reports were on "The Cause and Prevention of Hernia"¹ and "A Suggested Step in Technic"² really a preliminary report of this completer discussion.

Beyond reasonable doubt Bassini's operation³ marks a turning point in the history of inguinal herniotomy, for it is only after his report that we are justified in speaking of radical cures. His essential contribution is, in my judgment, the resection of the inguinal canal portion of the hernial sac, which he accomplished both theoretically and practically. Before his report, surgeons did not completely resect the sac, while since that time resection or at least destruction of the sac is the *only* universal feature in all technics. This procedure alone will probably cure at least three out of every four small or even medium sized hernias. The fact is, the Kocher technic,⁴ which is concededly nothing more than a decidedly complicated method for high ligation of the sac, gave rise to the reports ranging from 92 to 97½ per cent permanent cures—fully equal to the Bassini reports of the time. While the Kocher method has justly gone out of fashion on account of its contra-indications and dangers, it remains for the student one of the most interesting and instructive phases in the history of inguinal herniotomy. While the original Bassini technic and the Bassini modified to bring the internal oblique and transversus muscles in front of the cord still have many adherents, the strong tendency throughout the world during later years has been to reinforce these muscles by flaps from the external oblique aponeurosis. This newer principle, generally known in this country as the Andrews imbrication method,⁵ in Europe as the Girard procedure,⁶ has a large and apparently unending list of minor modifications.

Inasmuch as anatomy forms the foundation on which every herniotomy must depend, and a large gap exists between the anatomist's and surgeon's description of the inguinal canal, let me here review the essential facts and add what I consider salient, though from surgical papers generally omitted points. The belly wall from without inwardly is made

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up of skin (cutis), subcutaneous fatty layer (panniculus adiposus), deep fascia—the muscles with their aponeuroses—deep fascia, an extraperitoneal fatty layer and finally internally the peritoneum. The spread-out tendon of a muscle, called an aponeurosis, is made up of paralleling strands of white fibrous connective tissue. The term fascia means wrapper, which in this region as per routine encases the muscles and aponeurosis on both surfaces. As both aponeuroses and fascias are made up exclusively of white fibrous connective tissue, they are indistinguishable either grossly or microscopically, in other words the distinction between these terms rests solely on their function. The part of this layer of deep fascia against the transversus muscle and continuing down to the inguinal ligament of Poupart receives the special name of transversus fascia.

With this explanation every surgeon should be able to understand the accompanying diagram of inguinal hernia, which strikes me as the simplest possible (see Fig 1). The self-explanatory terms abdominal and subcutaneous rings (*annulus inguinalis abdominalis et subcutaneus*) are used in the Basle *Nomina Anatomica* revision of anatomical nomenclature (BNA) instead of the old terminology (OT), internal and external rings, respectively. Further, the transversalis muscle has been changed to transversus. As the terms external and internal have been widely used both in relationship to the midline of the body and to the depth from the surface, all modern anatomists have discarded the terms external and internal in relation to the midline of the body, and in their place substitute lateral and medial. This is a typical example of the possibility of confusion in the old terminology, for the external, that is superficial, ring is internal as related to the midline of the body. The subcutaneous ring and the anterior wall of the inguinal canal are correctly described and understood in most anatomic texts, but the abdominal ring and more particularly the posterior wall seem to have been universally overlooked or misunderstood by surgeons. To describe the posterior wall, from inside the abdomen outwards are the peritoneum, a variable layer of extraperitoneal fatty tissue and the transversus fascia, this transversus fascia is reinforced across its anterior surface by the *falx aponeurotica inguinalis* and the *ligamentum interfoveolare* of Heesselbach, as shown in Fig 2. The *falx aponeurotica inguinalis* (falx-sickle) is that part of the insertion of the combined internal oblique and transversus aponeurosis, which attaches to the inguinal ligament and also along the pectineal line of the ramus of the pubis for a variable distance laterally, averaging perhaps about an inch and a half. Its lateral edge thins out and blends with the transversus fascia. The *ligamentum interfoveolare* (fovea-pit) extends from the inferior margin of the transversus muscle, anterior to the transversus fascia, and blends inferiorly with the inguinal ligament of Poupart. As muscle fibres continuous with the transversus run into this ligament, His¹ in a minority opinion suggested calling this structure the *musculus* and

aponeurosis interfoveolare When well developed the edges of the ligamentum interfoveolare and the falx aponeurotica inguinalis blend, so that no medial fovea exists The fact is Henle,⁸ one of the early students of the problem, considered blending of the edges the normal anatomic condition However the anatomists may finally settle the finer technical points, the essential fact is that the whole area between the inferior margin of the transversus muscle and the inguinal ligament of Poupart is protected by the transversus fascia, reinforced throughout most of its extent by broad sheets of aponeurosis The only anatomic opening is where the cord (funiculus spermaticus) pierces the transversus fascia and this is reinforced at its danger point, inferiomedially, by the inferior portion of the ligamentum interfoveolare

All anatomies, so far as noted, stressed the importance and strength of this transversus fascia and the overlying aponeurosis layers Most of the surgical discussions on the other hand simply mention this fused layer mechanically, without laying one particle of stress on it, or even go to the extreme with Polya,⁹ who after a very complicated description states its strength is not worth considering Which brings us to the question of which group are correct and how this difference of opinion came about? I believe the anatomists are correct in their description of what they are much more familiar with, *ie*, the normal status, while those surgeons who do not admit it has any particular strength are describing the abnormal, *ie*, when the layer has become atrophied under continued pressure of a very large hernia, or more particularly when it has been damaged by a previous operation I agree emphatically with the anatomists that this fused aponeurosis fascia layer is functionally the essential factor in keeping intestines from entering the inguinal canal The fact is, this layer is sufficiently strong in practically all individuals to prevent hernias from really entering the inguinal canal, except at its point of least resistance along the spermatic cord In my dissecting room tests of the six bellies opened this year, I could not push my gloved finger through the transversus fascia aponeurosis at any point, except directly against the spermatic cord Genuine direct hernias are simply a relaxation and bulging outward of this layer, and practically never form a true sac or enter the scrotum (See Moschowitz's discussion,¹⁰ page 42) This is popularly very much understood because many surgeons diagnose every large-necked hernia, which from its nature extends down close to the lateral margin of the rectus muscle as direct On the other hand, fully half of the hernia recurrences are direct, but this only shows that after our usual herniotomy technics this layer is no longer strong and resistant—a proposition I will discuss in more detail later For those surgeons still skeptical about the normal strength of this fascia aponeurosis sheet, a simple test in their next small or medium-sized herniotomy would be to put their index finger through the neck of the hernial sac into the belly cavity and then press forward against the layer On their conclusion

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from this test I am willing to rest this anatomic discussion of the posterior wall of the inguinal canal

With these preliminaries out of the way I am ready to give the theory on which I developed the operation now to be described. As a matter of fact I worked out my own theory, but as Bassini went at the position on absolutely the same basis, I will quote him. Let me translate those characteristic statements as literally as possible (*Arch f klin Chir* vol xl, p 435) "I thought to myself that this could be worked out by means of the rebuilding of the hernial canal, as this exists under physiologic conditions, that is, a canal with two openings, an abdominal and a subcutaneous, further with two walls, a front and a back through the middle of which the spermatic cord would run obliquely." Later on page 441 he rediscusses the physiologic anatomy of the canal and then states, "In order to make possible the radical cure of inguinal hernia, it is, according to my contentions, indispensable that the original physiologic (valve) type of the inguinal canal be reproduced."

In my judgment, his theory grasped the essence of the problem, and even after the lapse of a generation I would not have the slightest desire to modify his statements one iota. But from the various operations advocated and used, it is self-evident that the surgical world has gotten further and further from his conception—in a word, has passed on and forgotten. But when Bassini came to applying his theory to practice, I personally feel that he made a grievous mistake, which chanced to swing the tide of all effort in the wrong direction. And so far as I could find out not a single protest has ever appeared in this literature until my preliminary report. It seems impossible that others have not hit on the same conception I have advocated, but at any rate they have never been able to influence the tide or even really make their protest heard. Bassini split the aponeurosis of the external oblique, separated out the hernial sac and then tied off the neck of the sac. Everybody followed suit. In justice to Bassini, let me call attention to the fact that on account of the danger of peritonitis during that stage of surgery, most operators refused even to open the hernial sac, using various torsion methods instead. His opening of the sac was a progressive step forward, and he was probably, subconsciously at least, influenced by his anxiety to close off the peritoneal cavity at the earliest possible moment. Bassini then resected the inguinal canal portion of the sac and proceeded to attempt to repair the abdominal ring and posterior wall of the inguinal canal. He aimed to sew the *musculus obliquus internus*, the *musculus transversus* and the *fascia verticalis Cooperi* (old name for *transversus fascia* and aponeurosis) down to the inguinal ligament of Poupert. But let me quote verbatim, page 437 "For the just discussed suture it is advisable to use silk and interrupted sutures, and to take hold of the three-ply musculo-aponeurotic layer at 2 to 3 cm from its (lower) edge. The lower two stitches—into lateral margin of rectus."

By what anatomic authority sew the internal oblique and transversus muscles down to the ligament of Poupart? As Bassini quotes none and it is not even mentioned among the occasional anatomic variations in reference volumes, I feel confident that he fell short of his own theory. That is why I feel he made a mistake, which has been universally followed. All of which refers purely to the physiologic anatomy of the canal, and is entirely aside from the question as to whether sewing these muscles down to the inguinal ligament of Poupart will yield a larger percentage of permanent cures. In my judgment, Bassini was right in maintaining he did not transplant the cord but he did transplant the muscles, at least temporarily. These statements apply, in my judgment, with equal force to the so-called anatomic modification, which consists in sewing the internal oblique and transversus muscles down to the inguinal ligament superficial to the cord (Wolfier,¹¹ Ferguson,¹² Girard,⁹ etc.) Bassini unquestionably aimed and thought that he had also sewn the transversus fascia and aponeurosis down to the inguinal ligament, but it is doubtful whether he ever really accomplished that object in even a small minority of his cases. With no protection for the intestines and with the peritoneal cavity closed, only a foolhardy surgeon would ever really catch the transversus fascia in even a single stitch. The fact is, most modern authors concede that they catch only the internal oblique and transversus muscles in their stitches. From the physiologic anatomy basis Bassini was therefore doubly wrong, as he caught the layer he had no warrant for catching and missed the layer he should have caught. No—the only practical way to catch the transversus fascia and aponeurosis is before the peritoneal cavity has been closed, in this operation before the hernial sac has been resected. Which is the practical kernel of my whole discussion.

As to the very important question as to whether, in a satisfactorily healed hernia, the internal oblique and transversus muscles usually remain strongly united to the inguinal ligament and functionably capable, I failed to find a single reference in a right intensive search. A recent German article by Druner¹³ refers to the conception that the internal oblique and transversus remain attached and functionally capable as an assumption which is no longer generally believed, but he does not give any special reference. Lameris¹⁴ evidently had some well merited curiosity on this point, as he tested the Bassini operation with the usual stitching of the internal oblique plus transversus to the inguinal ligament, as contrasted with absolutely the same technic except for omission of these stitches. His results on indirect hernias exclusively, checked at 1 to 1½ years postoperative are given in table 1. In 1918 he reported a second series, without stitch, which was done to verify his original results. The details of this second series, included in the same table, can be located through reference¹⁵. As this 4 per cent difference between the two groups is well within the normal variation of figures, his evidence would tend to show that the attempt to sew those

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muscles to the inguinal ligament of Poupart is an unessential and at any rate minor factor in the result

In recurrent cases Polya⁹ and in this country Moschowitz¹⁰ report observations on these muscles being separated either in part or throughout, or becoming as thin as sheets of paper. But they both consider this separation the cause of the recurrence and therefore argued for non-absorbable sutures. Moschowitz, however, seems to glimpse possibilities beyond his conclusion when he states, "The transplanted muscles always tend to pull away from Poupart's ligament, at best there is little tendency for firm union between muscle fibers and ligamentous tissue." In recurrences I have always observed separation of internal oblique and transversus muscle from inguinal ligament, but to date have not had opportunity to examine non-recurrent cases after a lapse of years.

TABLE I—Statistics of Lameris of Utrecht University

Indirect hernia only	Number of cases	Recurrences	Percentage
With stitch (internal oblique to inguinal lig of Poupart)	511	20	3.9%
Without stitch (internal oblique to inguinal lig of Poupart)	443	21	4.7%
Without stitch (internal oblique to inguinal lig of Poupart)	177	6	3.4%
Total without stitch	620	27	4.3%

Which brings us to the much mooted question as to whether it is weakness in the muscles, or aponeuroses and fascia, as cause of hernias. And the answer strikes me as very obviously both, for if the muscles are paralyzed the resultant relaxation of the aponeuroses and fascias allows a hernia to gradually force its way out, while on the other hand, anatomically, both walls, the subcutaneous ring and even the greater part of the abdominal ring are formed exclusively by aponeuroses and fascias. Further, not only do I believe that sewing the internal oblique and transversus muscles down to the inguinal ligament will not accomplish any good, but, let me add, the more conscientiously an operator attempts it, the worse will be his results. For if he just picks up a few muscle strands in his stitches, little damage will have been done when his stitches cut through, whereas when he gets a good grip on both muscles and inguinal ligament and attempts to really pull these layers together—well, the most fortunate outcome possible, in my judgment, would be to have his knots untie. The universal directions are to pull these layers together without undue tension, to which I now answer that even in average cases it cannot be done. I believe these stitches cause pressure necrosis and in a short time cut through the muscles or inguinal ligament to the point at which excessive tension is relieved. Which means the destruction of a certain amount of muscle tissue, but what is practically of even much greater importance, the loss of motor nerve supply to the muscle, medial to the injury.

This to my mind accounts for the great percentage of recurrences medial to the inferior (deep) epigastric artery, whereas without preceding operative intervention true hernias scarcely ever form in this region, *i.e.*, the medial focea

After all these complicated facts and theories, the steps in my technic are simplicity itself. Using the routine skin incision, I go down into the aponeurosis of the external oblique opposite the abdominal ring, even in primary operative cases, and then work somewhat more cautiously as I approach the cord exit at the subcutaneous ring. Inserting a blunt-pointed forceps through the subcutaneous ring just under the external oblique aponeurosis, I split this aponeurosis, being careful to remain in the direction of its paralleling strands (see Fig 3). Then lift up the spermatic cord and hernial sac en masse and dissect out the inguinal portion of the sac (see Fig 4). Then open the sac and insert my right finger through the abdominal ring, examining its boundaries, locating the deep epigastric artery, and finally testing the whole of the posterior surface of the transversus aponeurosis-fascia down to the lateral border of the rectus muscle. The question of intestinal adhesions, sliding hernias and bladder proximity should also be watched for, because, if present, they obviously call for special watchfulness in subsequent steps. In recent cases the tissues around the abdominal ring ordinarily do not feel especially strong, but in cases of longer standing these tissues tend to become thickened and even contracted down, which I interpret as Nature's attempt at cure. The fact is, this scar tissue and tendency towards contraction was so marked in the majority of long-standing small and medium sized hernias as to make me feel that Nature was generally ready to help out the surgeon who failed to close the abdominal ring effectively. As regards the transversus fascia and its overlying aponeurosis, I have been throughout impressed by its strength, even in certain cases in which relaxation could be noted by external examination. For example, I have never chanced to find any localized weak point, which tempted me to reinforce by overlapping or stitching, although I have been on the lookout for it—except of course in recurrent cases.

To close the abdominal ring I cut off the hernial sac to within about one-quarter inch of the ring (see Fig 5), then by means of three or four forceps around the circumference I hold the ring well open and insert my suture as shown in Fig 6. Full curved, medium sized needle, round point, No 2 tanned catgut, using mattress principle, in children or weaklings No 1 tanned fulfills all requirements. A simple running stitch is not at all equivalent to these mattress stitches either theoretically or practically. The first suture through the transversus fascia and aponeurosis about one-quarter inch beyond the ring margin as determined by palpation, then out through sac, and then a good grip on the inguinal ligament of Poupart, that is between one-eighth and one-quarter inch from edge, which means that it really catches the fascia lata of the thigh and the aponeurosis of the external oblique as well, then into the neck of

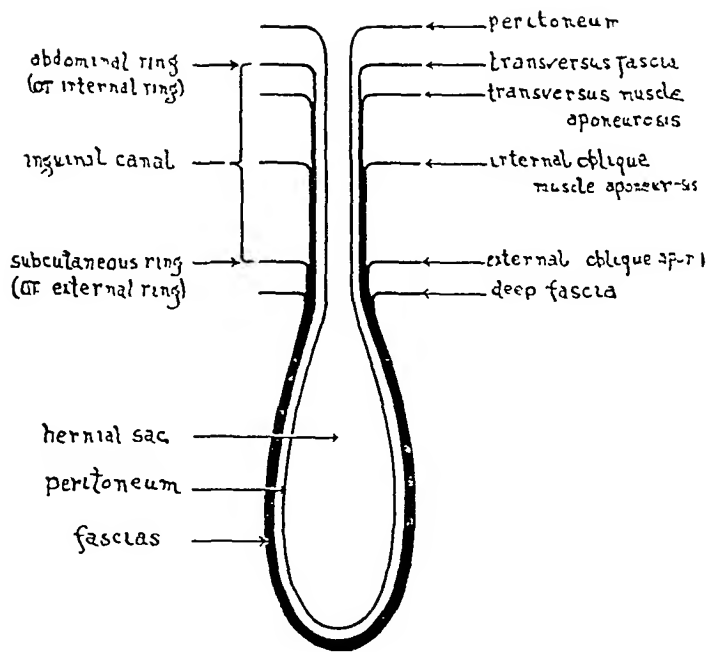


FIG 1 —Diagram of Inguinal Hernia (From the authors Fundamentals of Human Anatomy—C G Mosby Co—1920)

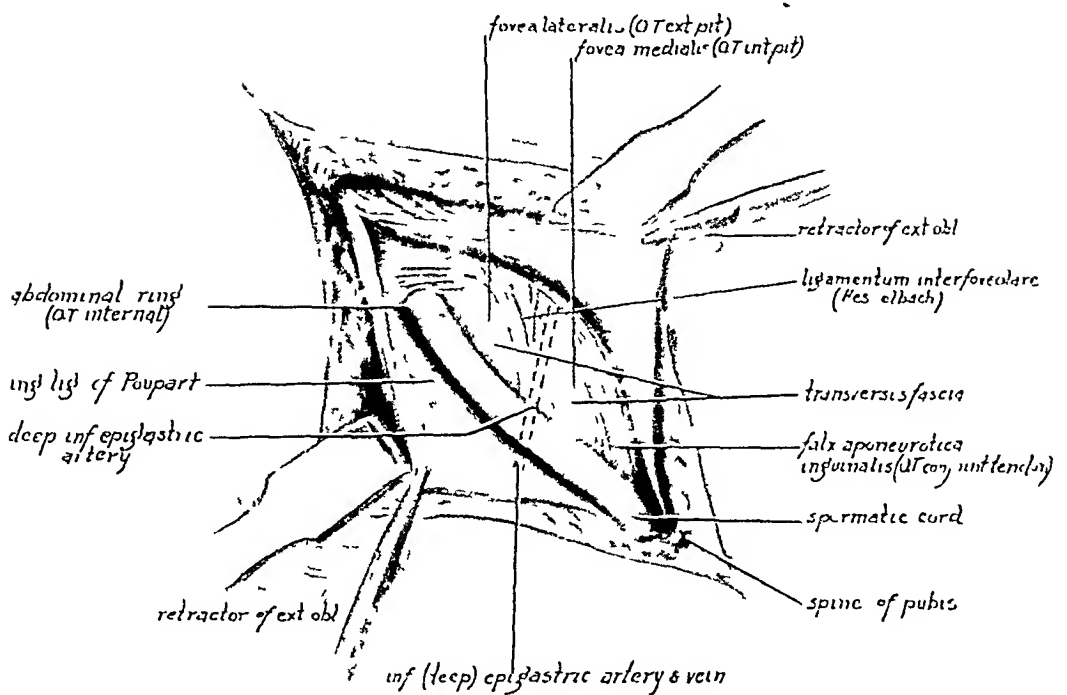


FIG 2 —Anatomy of Inguinal Region (Extra fascial fat removed)

↖ ant sup spine
crest of ilium

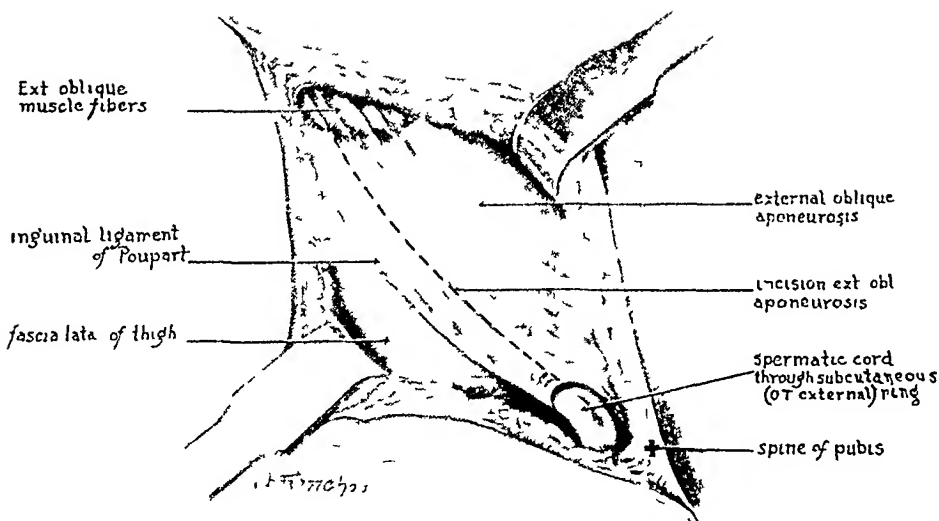


FIG 3 — Exposure of operative field

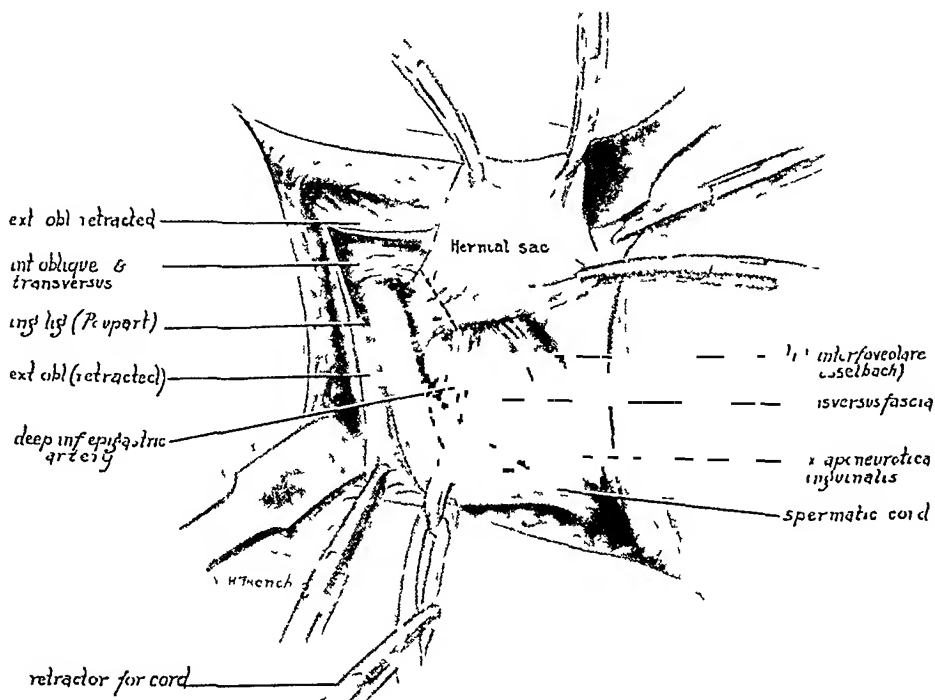


FIG 4 — Separation of hernial sac

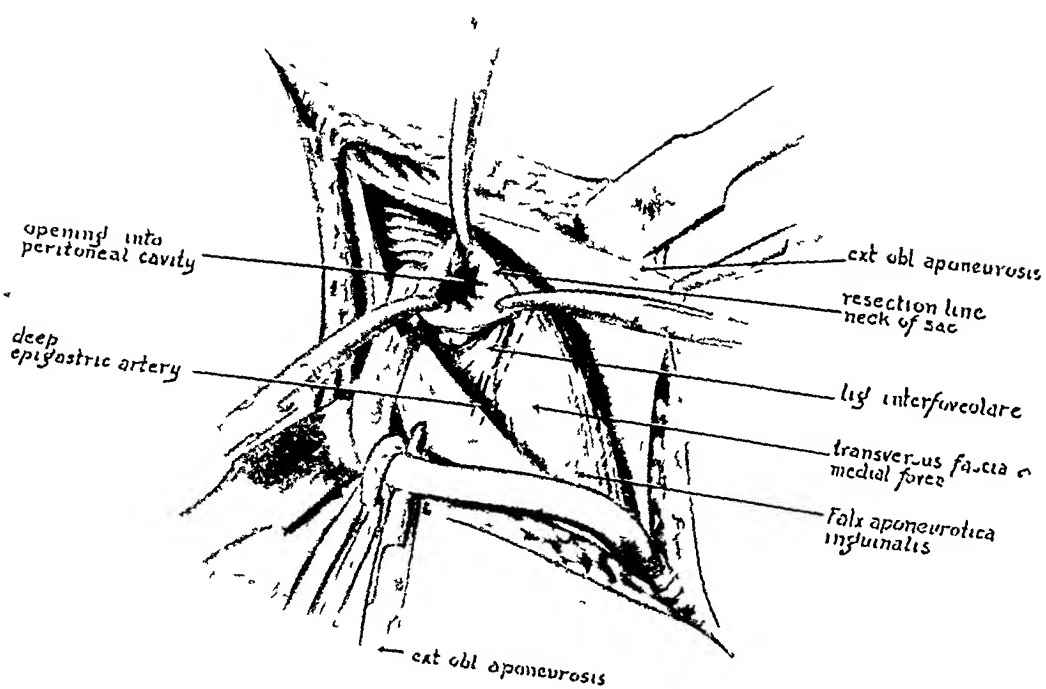


FIG 5 —Resection of hernial sac

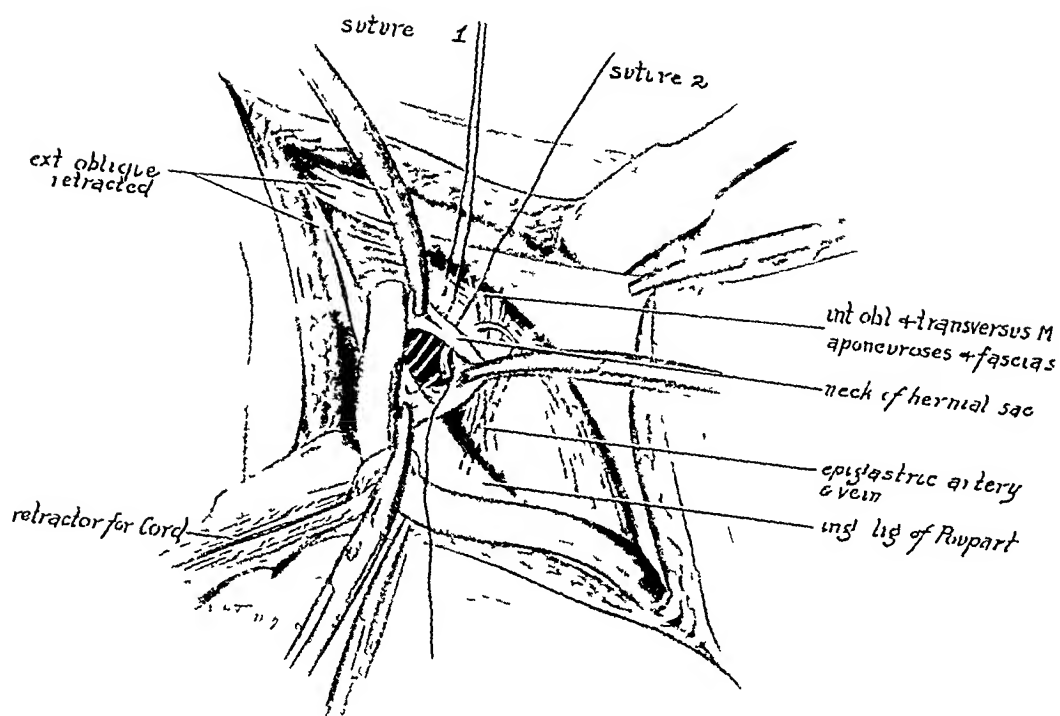


FIG 6 —Insertion of interrupted sutures

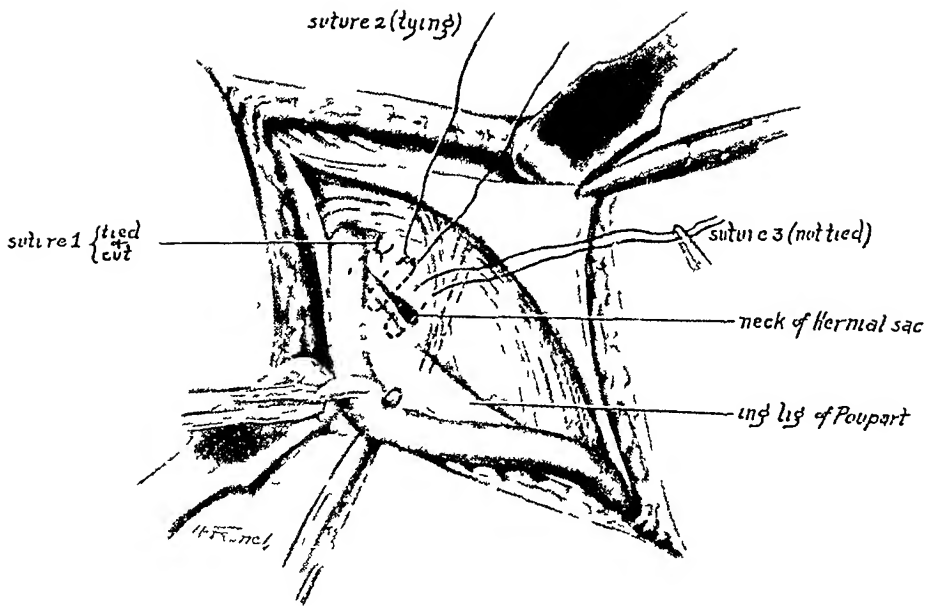


FIG 7 —Tying of sutures

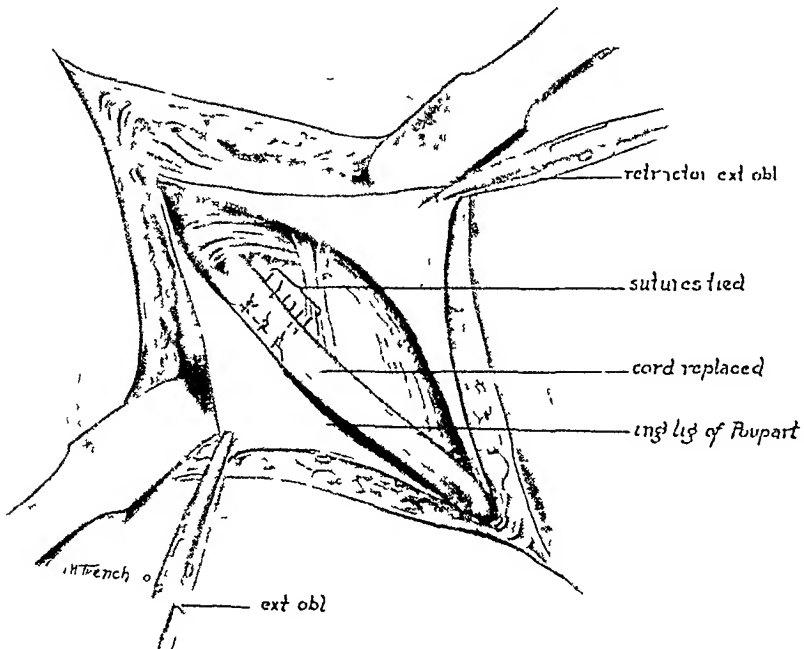


FIG 8 —Replacement of cord

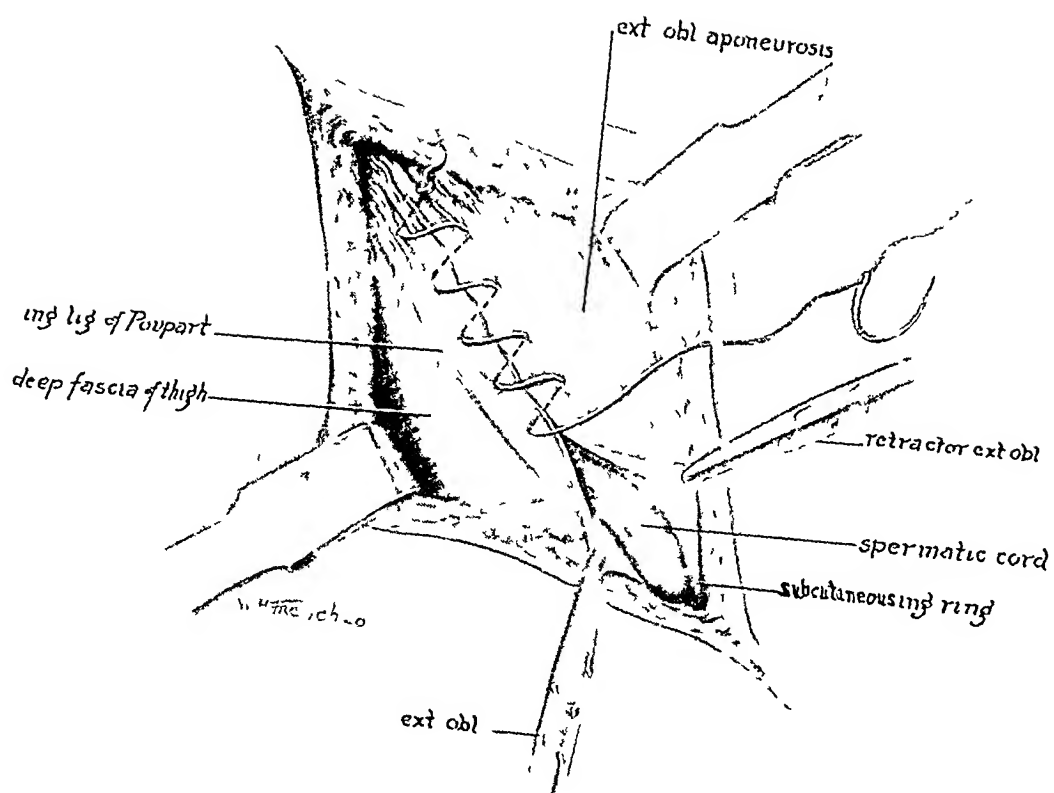


FIG 9 —Suture of ext oblique aponeurosis

the sac and through the transversus fascia-aponeurosis from within outwardly at somewhat over one-eighth inch from start of this mattress suture. Absolutely reversing the usual procedure, I avoid the internal oblique muscles as much as practical in inserting these sutures, in fact use a retractor to get these muscle fibres out of the way whenever they overlap the opening in the transversus fascia-aponeurosis. Of course the inguinal ligament should be absolutely cleared and also lifted up to avoid the possibility of injuring the femoral vein. The first suture should be placed sufficiently high so as to just leave room for the cord when the catgut is drawn down tight. Remaining sutures spaced about one-fourth inch apart on absolutely the same principle, which means a total of two, three, four and even five or more, as the individual case may call for.

The accompanying plates picture the repair of an average hernia, but let me emphasize here that the same principles in my judgment underly the repair of all inguinal hernias. In many cases one suture reduces the opening in the transversus fascia-aponeurosis to its normal size, while when the split in this layer has extended down to the lateral margin of the rectus muscle, obviously about a half dozen sutures are required. As any established technic will cure the overwhelming majority of small-necked hernias, my interest centres in the use of this technic in the medium, large and largest-necked hernias. Whether these very large-necked hernias are primarily direct, or, as I agree with Moschowitz and others, indirect, is a point of only academic interest as far as this operative procedure is concerned. For whether or no, the underlying principle of this technic is to restore valve action by the effective repair of the posterior wall and the abdominal (O T internal) ring.

After all the required sutures are inserted they are snugly tied from above downwards, three knots and over $\frac{1}{8}$ -inch cut, as otherwise catgut is very liable to untie and my theory is to have these layers hold together for at least ten days (see Fig 7). These stitches, I claim, can be tied without undue tension in most all cases. In regard to the very slight amount of tension necessary to hold the opposing layers together, catgut, being materially larger than silk or any other non-absorbable suture now used, has decidedly less tendency to cut through the tissues. If in any individual case coaptation without undue tension could not be accomplished, I would certainly feel that this indication called for the insertion of a free aponeurosis-fascia transplant, which I would borrow from the thigh. (See Kirschner's¹⁶ experimental work. In my judgment the advantage of a neighboring flap, with its temporarily better lymphatic circulation, is much more than counterbalanced by its injury to the strength of the abdominal wall, which is—lest we forget—what we are out to repair. But if you just must have a pedicled flap, my suggestion would be to borrow it from the front of the thigh.

The cord is then placed in its normal position and the aponeurosis of the external oblique sewed over it (see Figs 8 and 9). Whenever a large hernia has caused a stretching of this aponeurosis I take out the

slack by overlapping the edges. At the subcutaneous ring the normal triangular slit, just large enough for the cord, should be reproduced as nearly as possible. To prevent a dead space I sew the subcutaneous fatty layer with a running stitch, and then close the skin, also with catgut. To clear the tissues rapidly and well, I make use of the well known gauze dissection, tie only the larger vessels in closing up, and depend to a great extent on a firm spica-dressing to minimize the early post-operative hemorrhage incidence. In inserting the deeper sutures I am always on guard to avoid the deep inferior epigastric artery, even though I rather feel it would ordinarily get out of the way of a round pointed needle. The accompanying vein is both theoretically and practically more readily caught by suture, but on tying this hemorrhage usually ceases. At times, however, I imagine persistent bleeding might call for special ligation. As regards the theoretical risk of having stitches go through into the peritoneal cavity, my contention is that they sink into the delicate endothelial layer and are covered over within a few hours.

This concludes my paper, as I am not going to attempt statistics of a recent limited series, more particularly as I feel that the value, or lack of value, of any proposed particular technic can only be determined by the results of other than the originator. As this technic has as its maximum aim the restoration of the dilated inguinal canal to its normal strength, naturally there will be recurrences, if the individual repeats the error which developed the hernia originally. The acme of technical possibility strikes me as being that our patients should be able to do what a corresponding normal group of individuals can do, with no greater liability for the development of hernia—nothing more and nothing less! Personally I have developed such a profound respect for anatomy as related to function that, if any non-anatomic technic lasts, I will always feel that somehow nature rebuilds and so compensates for the surgeon's error. As a final word let me simply add my firm conviction that if the theory of this operation is better *ipso facto* the practical results will be better.

SUMMARY

1 Size and endlessness of the stream of inguinal herniotomy technics raises the strong suspicion that something is fundamentally wrong.

2 The essentials of the original Bassini, the Kocher, and the more recent imbrication technics, Girard-Andrews.

3 The anatomy of the inguinal canal, with special stress on the posterior wall and abdominal ring—including a detailed discussion of the transversus fascia, the falx aponeurotica inguinalis and the ligamentum interfoveolare.

4 Differences between the anatomist's and the surgeon's description and conception of the inguinal canal.

5 Bassini's original theory of the operation, which, verbatim, fulfils my conceptions completely.

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6 The basis for my conception that Bassini failed to apply his theory correctly to practice

7 In order to catch the transversus fascia and overlying aponeurosis in the stitches, it is in my judgment absolutely necessary to insert the stitches before the hernial sac has been closed

8 Questions as to whether the internal oblique and transversus muscles remain functionally attached to the inguinal ligament of Poupart in even non-recurrent cases

9 The evidence that both normal muscles, and normal aponeurosis and fascias, are essential to prevent and cure hernias

10 Technic of my operation, the essential step being to sew the transversus fascia and aponeurosis—and only these layers—down to the inguinal ligament of Poupart before the peritoneal cavity has been closed

11 The reasons why I feel that this technic is universally applicable to all inguinal hernias, small or large, direct or indirect, primary or recurrent, especially advocated for medium and large-necked hernias

12 The aim of this technic is simply to minimize recurrences, including why, as a practical proposition, some recurrences will always occur

CONCLUSIONS

The underlying principle of this operation for the repair of all types of inguinal hernia is the reproduction of physiologic valve reaction by (a) resection of the hernial sac, (b) actual effective repair of the enlarged opening in the transversus (transversalis) fascia (c) avoidance of injury to the internal oblique and transversus muscles

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INCOMPLETE RUPTURE OF THE AXILLARY ARTERY

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WHILE complete and open ruptures of the big vessels have been well described by the military surgeons of the last century, incomplete ruptures of the arteries did not attract so much attention at that time. However, this condition had been known for many years in civil practice and it has been the subject of several important observations during the World War.

The management of these cases is still far from satisfactory, no definite method of treatment has been evolved so far, and for this reason these injuries should be more frequently reported in order to stimulate surgical thought and reflexion that will eventually lead to a more active and effective therapy. Here is a short account of the two cases we have observed.

CASE No I J W, fifty-five years old, farmer, was thrown from an automobile on August 27, 1918, injuring his left shoulder. He came to San Francisco on August 30, 1918, with the diagnosis of fracture of the surgical neck of the left humerus, attended by great displacement of the lower fragment (shaft) into the axilla. From the day of his admission no pulse could be felt in the radial, ulnar or brachial arteries at any time. The fifth finger was white and swollen, but the patient could still move all his fingers. On September 8th, a patch of ischæmic necrosis appeared on the ulnar side of the forearm near the wrist.

After two unsuccessful attempts at reduction had been made, we performed, on September 9th, an operation consisting in the excision of the humeral head and reduction of the shaft into the glenoid cavity. But the ischæmic gangrene kept increasing slowly until the patient finally lost four fingers with part of the metatarsals, the forearm remaining in a typical state of Volkmann's ischæmic paralysis.

Injuries of this kind are well known in the surgical literature, the only point of interest lies in the fact that in this case we could inspect and feel the thrombosed axillary artery exposed during the operation, it was spindle shaped, hard and pulseless, the adventitia was still intact, so that a diagnosis of rupture of the tunica intima and media was made. The thrombus appeared to be from two to two and one-half inches in length and its removal, followed by double ligation of the axillary artery, would have been quite feasible, but we were not sufficiently familiar with the condition and with the more recent publications thereon to dare to take such a risk at that time.

CASE No II A M, twenty-nine years old, railroad conductor. On December 5, 1920, while engaged at coupling two railroad cars, he was caught between one car at his back and a heavy piece of timber projecting from the car in front and pressing against his sternum, he esti-

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mates that he stayed in that position for thirty-five seconds, and while his thorax was held tight between the two cars he tried to signal to the engineer of the train by waving his left hand. He says that he extended his left arm three or four times and then dropped it towards the ground. In the local hospital soon after the accident it was found that the second and third costal cartilages on the right side were broken, near the sternum. His left arm was numb and heavy, but he had no pain in it. The third, fourth and fifth fingers were ice cold. The radial pulse was absent.

On December 7, 1920, we examined the patient in San Francisco. His general condition of health was excellent. As to the left arm there was no pulse in the radial, brachial or axillary arteries. The arm was cold and anæmic, but a faint pink color could always be detected near the lunula of the nails. The fingers felt numb and heavy, but he could move them. The skin and muscles were perfectly soft, we watched the patient every day for the appearance of any ischæmic patches, but none came. He was treated with constant warm applications to the whole arm and rest in bed for several weeks, on account of the danger of embolism. There was no swelling or sign of extravasation about the neck or the axilla.

On January 2, 1921, the pulse was still absent, but the influx of blood was apparently sufficient as the arm was warm and the skin veins were beginning to show very well, it was also noted that the man had a much better grip.

On January 13, 1921, thirty-nine days after the accident, a faint pulsation could be felt in the radial artery, then it disappeared.

On January 18, 1921, forty-four days after the injury, the pulse could be felt again, it was soft but quite distinct.

On February 12, 1921, ten weeks after the injury, the pulse was excellent, the muscles were soft and strong. There was no pain and no swelling of any kind about the axilla.

So it took ten weeks for the collateral circulation to be firmly established in this case.

Remarks Etiology and Mechanism —(a) Rupture of the inner coats of the arteries may be caused by direct violence applied to the vessel, for instance, in the case of a wagon wheel going over a limb (Lejars), or in hanging and strangling (Herzog), or if a bullet or a piece of shell strikes an artery directly but weakly and tangentially (Sencert, Anderson, etc.)

(b) The rupture may be due to indirect shock or contusions, as in fractures and dislocations, or when the bursting of a muscle is caused by bullet or a shell (Hydraulic pressure of Gregoire). Sencert, Dobson, Higgins and other military observers all confirm the fact that a bullet passing at a distance from an artery (and not through it) may set up such a *vibration* and shaking up of all the parts as to cause a tear in the vessel.

(c) Another mechanism is by elongation or overstretching. The best example of this is the case of Turner (quoted by Lejars) of a patient putting his hand in his hip pocket, after which the artery was found obliterated. Our Case No. II evidently belongs in this category.

All military surgeons (Anderson, Sencert and others) assert that a piece of shell going through a limb can have the same action by putting an artery on the stretch

All these mechanisms are certain and all have been verified at operation and at post-mortem

According to the experiments of the French Military School, quoted by Sencert, there are three degrees of injuries to the internal coats of an artery

- 1 In the first degree, a few lines (or cracks) are seen in the intima alone
- 2 In the second degree, ruptures of the intima and media are found with some curling of the torn edges, but these are limited
- 3 In the third degree there is a complete circular rupture of the intima and media

The consequences of such lesions vary to a great extent (according to Sencert) In mild cases with a very small thrombus, no changes or only a slight narrowing of the vessel may be present, in others, the injured vessel is spindle shaped, owing to the distention of the adventitia In others, the thrombus may be so long as to fill the first, second or third collateral Again in other cases the thrombosis may be so extensive as to reach the next big artery (carotid) and this has resulted in embolism and hemiplegia in several instances

Diagnosis —Sencert states that in mild cases with a small thrombus the symptoms may be transitory, the pulse being present all the time, but these are surely exceptional

In the great majority the absence of arterial pulse is the most striking symptom, and if the extremity is pale, cold, insensible, the diagnosis of a ruptured artery is certain

In severe cases the ischæmia may appear from the beginning, as indicated by pain, cyanosis, edema, impairment of motion and the peculiar hard consistency of the skin and muscles of the affected areas

The surgeon will do well to look out for any sign of incipient ischæmia before he undertakes any intervention, and to have one or two of his colleagues in consultation, otherwise if the gangrene should become apparent after the operation (such as reduction of fractures or dislocation) the patient will not fail to regard the surgical intervention as the cause of the trouble

As to the differential diagnosis between complete and incomplete rupture of an artery, we have to bear in mind the fact that, owing to the curling up of the inner coats, a complete rupture of a large artery may take place without hemorrhage or hæmatoma to speak of This is known to have arrested the bleeding in many cases of injuries of the large vessels

Makins states that the diagnosis between contusion-thrombosis and complete division of an artery is impossible if there is no systolic bruit or aneurismal swelling

In our Case No II, we have admitted an incomplete rupture of the axillary artery, chiefly because of the absence of hæmatoma and aneurism,

this, however, is only a diagnosis of probability and the rupture may have been more complete than we really thought it was

Prognosis —Inasmuch as we have no accurate means to estimate the location and the size of the thrombus, our prognosis should be well guarded both as to the future condition of the limb and as to the life of the patient. Experience shows that only a minority of the cases will be completely cured. The majority will result in amputations and a few in death by embolism.

The prolonged absence of pulse does not necessarily entail a bad prognosis, as instanced in the case of Lejars in which the radial pulse made its reappearance four months after the accident.

Treatment —Up to the present incomplete ruptures of the arteries have received only palliative treatment, as far as we know.

A direct suture of the vessel is not indicated, of course, in lesions of the inner coats alone. As to other procedures, Anderson has tried Tuffier's tubes and some vein grafts too, he says, without result. Free transplantation of a piece of vein to take the place of a resected segment of artery has succeeded in the treatment of aneurisms and tumors, but has little value in traumatic injuries where the collateral circulation has had no time and no chance to develop.

Anderson seems to regard ligature where not done too early (five or six days after the injury) as the most favorable treatment.

Speaking of complete subcutaneous ruptures with hæmatoma, Lejars says that it is recommended to make an incision, clean out the blood clots and ligate the artery, but he adds that nobody has done it very much.

In the future we would follow the advice of Sencert, which is as follows. In mild cases, with absence of pulse but with no other alarming symptoms, watchful waiting is all that is necessary, with absolute rest of the injured limb, of course. In serious cases, with incipient ischæmia, when one or two fingers (or toes) are decolorized and begin to feel "hard," we know what the patient has to expect—the loss of several fingers or of the whole hand with an extremity that will remain shrivelled up and atrophied, and this seems to justify a more aggressive therapy on our part. This should consist, according to Sencert, in a longitudinal arteriotomy, and removal of the thrombus with double ligation of the artery above and below the point of injury, the fundamental idea being to try to relieve and open up the collaterals. He does not say that he has done it and he does not give any result, but this suggestion certainly sounds rational.

Will it ever be possible to add to this operation some other procedure, such as an anastomosis between two secondary arteries, one distal, the other proximal to the injured joint, done directly or by means of a neighboring vein? For instance, in case of a ruptured axillary artery, could an anastomosis be effected between one of the scapular branches and the profunda brachii directly or indirectly (through a vein)? We know that such a junction between vessels of small calibre is particularly liable to thrombosis. The future will answer this question, but the prospect of Volkmann's ischæmia is so

sad that it ought to spur the surgeons to make all efforts possible in order to prevent this most lamentable occurrence, if it can ever be done

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ARTERIAL HÆMATOMA FOLLOWING TRAUMATIC RUPTURE OF THE POPLITEAL ARTERY

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SINCE in a strict sense the word aneurism connotes an actual yielding or dilatation of the wall of a blood-vessel, the term arterial hæmatoma is best used to designate solely those arterial ruptures formerly described under the erroneous and misleading caption, false or traumatic aneurism. Yet, the distinction between a true aneurism and an arterial hæmatoma may become, at least from a histologic viewpoint, wholly artificial, because microscopic study shows that endothelium does not enter always into the formation of the lining of an aneurismal sac. Again, a sac itself may not be entirely composed of structures derived primarily from the wall of the artery. Indeed, the wall of a sac may be formed of firmly compressed and agglutinated layers of thrombus. Nevertheless, a distinction is needed because the surgical treatment of aneurism—obliteration or extirpation of the sac or restoration of the vascular continuity—is wholly different from that of arterial rupture.

A striking example of traumatic rupture of the popliteal artery is the following

M D, age twelve, entered St Francis Hospital May 4, 1920, discharged June 7, 1920

The previous and personal history of the patient is of no moment

Present illness dates from an injury of the right leg sustained by falling from a boardwalk three months ago. A swelling which appeared immediately following the accident has constantly but slowly increased in size, without any symptoms of sepsis. The swelling is confined to the lower one-half of the right thigh, and is more prominent over the internal aspect. There is neither heat nor tenderness. The swelling is cystic and tense. A roentgenogram taken by A J Qumby, M D, shows no disease of the bone or periosteum. Despite this negative report a tentative diagnosis of periosteal sarcoma was made.

Operation (May 7, 1920) —Ether narcosis. A longitudinal incision was made over the most prominent part of the cystic swelling. Upon deepening the incision through the muscles of the thigh a large cavity was entered, containing a large amount of black and gangrenous blood clots. These clots, compressed into definite laminae, formed a distinct wall to the cavity. In attempting to remove the organized blood clots, a violent hemorrhage was encountered. The bleeding being clearly of arterial origin, the common femoral artery was immediately compressed in Scarpa's triangle. The incision was then rapidly enlarged. By holding the margins apart with retractors and asking the assistant to release the pressure from the femoral artery an opening was de-

tected on the inner wall of a large blood-vessel which was afterwards identified as the beginning of the popliteal artery. The wall of the artery was gray and somewhat necrotic. Double ligation of the artery with No. 2 chromic catgut sutures, passed with an aneurism needle, effectively controlled the hemorrhage. Following the insertion of two pieces of gauze into the wound, the remainder of the incision was closed with interrupted sutures. During the latter part of the operation the patient passed into profound shock. The use of Trendelenberg's position and active hypodermic stimulation resulted in an immediate recovery.

The post-operative treatment consisted simply in the daily removal of gauze and packing of the wound. The color and warmth of the limb remained unchanged throughout the convalescence. Pulsation of the dorsalis pedis artery never could be obtained. Complete cicatrization of the wound took place leaving a firm linear scar. Patient was discharged cured June 7, 1920.

The incision, which was about five inches in length, terminated about two inches above the internal condyle of the femur. Compression of the common femoral artery and vigorous retraction of the incision afforded a clear and dry field, in which the ruptured artery could be clearly seen. In the center of the artery, as stated above, was a longitudinal tear, through which blood spurted to a considerable height the moment the compressing finger was released. The accompanying vein could not be isolated. Following the occlusion of the ruptured artery with two hæmostats and the removal of the compressing finger over the common femoral artery, the structure could be felt to pulsate forcibly, proving conclusively that the injured vessel was an artery and not a vein. From the gross appearance of the ruptured artery it was evident that the wall had undergone severe contusion and softening.

The hemorrhage was recognized by the wound filling rapidly with blood and by hearing a hissing sound, indicating the escape of blood under great pressure. Ordinarily, the dissection and exposure of the popliteal artery at this site would be exceedingly intricate. The hæmatoma, however, having dissected and displaced the various muscle planes, made the exposure of the artery extremely simple. Indeed, the increasing pressure of the hæmatoma had eroded, to a definite extent, the posterior surface of the lower end of the femur. The portions of organized blood clot removed manually, constituted the postero-internal wall of the sac. They measured, at least, one-half inch in thickness and resembled greatly portions of placental tissue.

Monod and Vanverts have published an elaborate and trustworthy analysis of the problem of arterial hæmatoma. In a series of 205 collected cases, there were eleven primary amputations, three indirect compressions of the affected artery, forty-one ligations and 157 direct incisions of the hæmatoma.¹ A noteworthy fact in this connection is that, in each instance, among these 157 direct incisions, a secondary operation—tamponade, ligation or arteriorrhaphy—became imperative.

It would appear, that the most efficacious treatment consists in the early

incision of the hæmatoma, since the prompt evacuation of the clots favors the immediate restoration of the collateral circulation. Hæmostasis is assured by double ligation of the bleeding vessel which, happily, may be a collateral and not the main trunk.

Arteriorrhaphy, lateral, longitudinal, circular or oblique, is a feasible method of treatment. Fine round needles and thin durable vaseline-soaked silk sutures are required. Above all, the breach in the wall of the artery must be comparatively small and not devitalized or excessively lacerated, for otherwise a secure closure is not possible. Suture of an injured vein is practicable. The advice of von Oppel to ligate always the accompanying vein of a main artery may be justifiably followed, though it is not clear that the operation rests on a sound basis.

Ligation of the principal artery of an extremity should be avoided, save as a last resort, because this operation facilitates the occurrence of gangrene by suppressing many of the branches most needed in the establishment of the collateral circulation. Moreover, ligation of the main trunk—for example, the common femoral—would not prevent reactionary or secondary hemorrhage from the popliteal artery if the sutured ends of this artery were not ligated. When an open wound exists, direct ligation of the ruptured vessel is simplified. In the absence of an open wound, the classical incisions for ligation of an artery in continuity are available.

No matter the method of treatment employed, drainage is absolutely essential, one important indication being the necessity to detect the early onset of reactionary or secondary hemorrhage.

Preliminary to ligation of a main artery one should make an effort to determine the efficiency of the collateral circulation, for it is evident that, if the collateral circulation be not established, ligation of the main trunk should yield, in order to avoid gangrene and consequent amputation, to the operation of arteriorrhaphy or, perhaps, venous transplantation. The latter procedure, used by Renans in reconstructing the popliteal artery following resection of a popliteal aneurism, is, generally, not feasible in this phase of traumatic surgery. This surgeon utilized a segment of the internal saphenous vein to bridge an interval of seventeen cm. between the separated ends of the popliteal artery.

Numerous tests exist to detect the failure of the collateral circulation. When the circulation is well carried out as evidenced by the non-existence of gangrene or necrosis, though the peripheral pulse be absent, it is evident that the collateral circulation is ample and complete. Again, the cessation of pulsation in a distal peripheral artery is not a criterion that the main trunk is affected, because compression of the main trunk may result from a hæmatoma of a secondary artery. Amberger and Delbet in two clinical reports call attention to the immediate restoration of the peripheral circulation following the evacuation of a hæmatoma. When the peripheral pulse is present, however, it becomes difficult to say whether or not the pulse is secondary or collateral in origin. In this connection, it is interesting to learn that Dob-

rovolskaia² maintains that he is able by a detailed study of sphygmographic tracings of the distal artery, to determine the origin, secondary or collateral, of the pulsation. But it would appear from the analysis of Dobrovolskaia's reports, that a considerable error underlies this method.

Korothow has devised a test which consists in a determination of the blood pressure of the toes or fingers following previous exsanguination of the limb and compression of the main trunk. Matas³, in a clinical application of this test, objects, particularly, to the difficulty met in applying the apparatus. In general, it would appear that the well known Moskowicz hyperæmia test is, perhaps, the best for clinical use.

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FRAGILITAS OSSIUM

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THE condition of fragilitas ossium, known by a number of other names, the more common of which are osteogenesis imperfecta and idiopathic psarthyrosis, is characterized by brittleness of the bones and blueness of the sclera. Eddowes noticed the association between the blue sclera and brittle bones in 1900 and he is generally given credit of being the first to describe this condition although Spurway claims that he reported a case of breakable bones in 1896.

With regard to the etiology, thus far, none of the advanced theories have proven tenable. For a long time the disease was thought to be on a syphilitic basis but this has been disproved, also because of its similarity to rachitic disorder it was confused with this condition.

Heredity plays a small but significant part in fragilitas ossium for, in between nine and ten per cent of the cases, we have been able to definitely trace the condition back to some relative, not necessarily parents or grandparents. However, often those of a family with predisposition for the disease and having blue sclera are affected and also transmit it to offspring, whereas those with white sclera do not. As only this small percentage of cases can be placed on an hereditary basis, we are left with a much larger group of cases about which we can say little concerning the etiology.

Pathologists report that in addition to a subnormal activity on the part of the osteoblasts there is a deficient deposition of calcium salts and other mineral matter in the ossious system of the patient. The ossification of cartilage is delayed or absent and very little dense bone is found. The bones may be characterized as being pipe-like.

The patients having the condition of fragilitas ossium also have blue sclera in every case. By several authors the sclera are described as being china blue. We have, however, cases of blue sclera in which there has never been any suggestion of fragilitas ossium, as in certain blood diseases and occasionally in tuberculosis, but the association in this disease is constant.

The fractures may occur in prenatal life, in which case they are more commonly confined to the bones of the head with occasionally fracture of the long bones. In those cases where fractures come on after birth we rarely, if ever, have fracture of the cranial bones but have the long bones chiefly affected. As most of the cases which suffer from prenatal fractures are still-born or die soon after birth, we are mainly concerned with the post-natal type. Naturally, the earlier the onset of the fractures, the greater the num-

ber of them the patient is liable to have. In some cases, the liability to fracture decreases with age, and, after the patient reaches thirty years of age, he has no more. Then again other patients still are having fractures at forty-six years of age. The long bones are chiefly affected especially the femurs. In addition to fractures, the bones on account of their imperfect osteogenesis, are very liable to bowing and sprain fractures are also very common. Because of the many fractures and the bowing, the majority of these patients are short in stature.

In all the case reports reviewed there was no reference to an abnormal condition of the teeth. Practically all referred to the teeth as negative or in good condition. In the case we are reporting, the child has a very interesting condition of his teeth. They are almost translucent and show every evidence of lack of mineral salts. The mother informed one of us that the first teeth were the same and did not last any time at all but were so fragile that they soon crumbled. The permanent teeth seem much the same as the deciduous set in this regard.

Radiographically we notice the shafts of the long bones are very thin in comparison to the size of the epiphyses of the same bones. The bowing or fracture, as the case may be, is always very evident.

Prognosis and treatment may well be combined for they are both very uncertain and equally unsatisfactory. As previously described the fractures may cease at thirty or may continue till midlife. All we can do is to apply splints or casts as necessary to the fractured members or try to avoid slight falls, sudden jars, etc. Medication is apparently of no avail. Various glandular preparations, bone marrow, tonics, etc., have been tried but found useless. So the treatment is merely symptomatic.

Report of a Case—W. G., age eleven, white, male, born in the United States. Admitted to the Albany Hospital, July 23, 1920, with fracture of the right femur.

Family History—There is no history of tuberculosis, syphilis, cancer, rheumatism, heart disease, etc. Father is thirty-nine, is well but has pigeon breast. Mother is thirty-seven, well and married seventeen years. Patient has one brother age nine and five sisters, ages six, eleven, thirteen, fourteen, and sixteen. All the children are marked blonds and have blue irides and very light hair. The sister age thirteen has blue sclera and teeth similar to the patient but never has had any fractures. With this exception all of the brothers and sisters are perfectly normal as far as superficial examination goes. The paternal grandfather is alive and well, age seventy-two. The paternal grandmother died at thirty-five due to accident. The maternal grandfather died of rheumatism and heart disease at sixty-five. Maternal grandmother died in childbirth, age unknown. There is no history on either side of the family of fractures or of blue sclera.

Past History—The patient had measles in infancy but otherwise has been well, except for his fractures, up till last winter when he had diphtheria. However, this was not serious or followed by paralysis.



Fig 1 —Most recent fracture of femur in case of fragilitas ossium

The patient was born without instrumental delivery and weighed seven pounds at birth. He began to talk at eighteen months and walked at three years.

History of Fractures — These began at six weeks of age. The child was being dressed by a relative who in turning him heard a snap and immediately the child began to cry. The next day, because of swelling and pain in the thigh, a doctor was called, and he pronounced the condition a fracture. From this time to the age of one and a half years he had no more fractures, due probably to the extreme carefulness on the part of his parents. Then he commenced to have one fracture as soon as the previous one would heal. These were all located in the femurs and mostly occurred in the right femur. He has had in all thirteen fractures previous to the present, a sudden turn or sharp twist often being enough to cause a new one. A considerable part of his time has been spent in hospitals and at home because of his fractures but of late years he has managed to get to school considerably. In addition to the fractures, there has been considerable bowing of the femurs since he began to walk and thus subjecting them to weight bearing. This is very evident in the accompanying X-ray pictures which in addition to the extensive bowing of the femur show the fracture. (See X-rays.)

The present condition was occasioned by a slight fall which would not have been noticed by a normal child of his years.

Examination of the patient shows him to be a fairly well nourished boy. In stature he is no taller than his six year old sister in spite of his eleven years. His skin is soft, elastic and relatively free from eruptions. He is somewhat pale but looks surprisingly good considering his previous inactivity. Mucous membranes are negative. The sclera are slightly blue. Pupils are equal and react both to light and accommodation. The ears are negative. The teeth are poor and present a peculiar translucency which has been described previously. The gums show considerable neglect being somewhat spongy and bleeding easily. The chest is of the type commonly called pigeon-breast. There is no beading of the ribs or other signs suggestive of rickets. The heart and lungs are essentially negative. The abdomen is negative as are also the genitals and rectum. Small glands are palpable along the posterior borders of the sternocleidomastoid muscles. None are found in the axillary and inguinal regions. Reflexes are normal.

Both femurs present marked external bowing and, in addition, the right presents a fracture with most of the usual signs of fractures, *i e*, abnormal mobility, crepitus, deformity, pain, etc. The femurs describe an arc of about 140 degrees. The epiphyses seem relatively larger than the diaphyses.

On admission to the hospital the temperature of the patient was 100 degrees but within a few days was reduced to normal. The pulse remained persistently accelerated, averaging ninety-four all during his stay in the hospital.

Laboratory Examination

The blood examination was as follows

Erythrocytes	6,192,000
Leucocytes	17,100
Hæmoglobin (Sahl)	100%
Differential count	45 1%
Polymorphonuclear neutrophiles	1 0%
Eosinophiles	5%
Basophiles	38 2%
Small lymphocytes	13 2%
Large lymphocytes	2 0%
Transitional cells	
	100 0%

The blood urea was 13.2 mg per 100 c c, the blood creatinin was 1.0 mg per 100 c c, the blood sugar was 13%

The Wassermann reaction was negative

Examination of a twenty-four hour specimen of the urine gave the following report —

Color—cloudy lemon, reaction—alkaline

Sp gr 1.008, negative for albumen and sugar

Microscopically triple and amorphous phosphates were seen with mucous shreds

The total nitrogen was 4.61 gms

The total chlorides 1.92 gms

Uric acid 0.117

A plaster-of-Paris case was applied to the injured member and as soon as the patient could get about on his crutches he was discharged from the hospital. As these cases require a long time to secure firm union, the case has been left on longer than usual for ordinary fracture cases. The medical treatment consisted simply of tonics and laxatives.

The prognosis is fair but with the number of fractures he has already had, rendering him virtually a cripple, the outlook for the future is not very bright.

Since preparing this article, the patient has suffered a new fracture of the opposite femur. It seems his pet kitten was on his lap and suddenly jumped, causing him to twist his leg ever so slightly, but, evidently, the force was sufficient to cause a fracture.

CONCLUSIONS

1. Fragilitas ossium is a relatively rare condition and is accompanied by blue sclera.

2. The etiology is unknown in the large majority of cases, less than ten per cent being on an hereditary basis.

3. There is no demonstrable relationship between fragilitas ossium and any other bone condition, as scurvy, tuberculosis, syphilis, osteomalacia, etc.

4. The treatment is very unsatisfactory and offers no hope of a cure.

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A TECHNIC FOR LEG AMPUTATION²

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OF KANSAS CITY, MO.

AN amputation should be done as carefully and with as much thought of future function as a herniorrhaphy or a gastro-enterostomy. Too little emphasis has been placed upon the importance of careful work in this operation. With this in mind I have attempted to perfect a technic that will eliminate as much as possible some of the common complications found in the ordinary amputation stumps, such as tender scars, ulcers and sensitive neuromata. Practically all artificial limb fitters agree that the most satisfactory site for leg amputation is in the middle third. This technic is chiefly for that type of operation, although it may be used higher or lower in the leg or even in the thigh.

Long anterior and short posterior flaps are made (Fig. 1). The long flap is made in order that the scar may be placed in a posterior position to free it from attachment to the bone or from pressure by an artificial limb. In the use of an artificial limb the propelling force of the stump inside of the socket falls on the anterior surface over or near the tibial crest. If there is to be any end bearing, the scar should not be placed on the end of the stump. The most important pressure point in end bearing is, of course, the end of the tibia. In making the anterior flap the deep fascia is included (Fig. 1). This is dissected back at least 3 cm. beyond the point where the tibia is to be divided.

The posterior flap is quite short and is dissected free for a short distance only. From the edge of the posterior flap the skin and fat are dissected downward and a flap of fascia (Fig. 1) freed of sufficient length to turn upward over the cut end of the stump. The muscles are then divided 2 or 3 cm. below the point at which the tibia is to be amputated. The cut muscles are retracted and the tibia and fibula sawed across (Fig. 2). The fibula is cut at least 1 cm. shorter than the tibia. Either before or after the bones are severed the periosteum is carefully removed about the cut ends for a distance of $\frac{1}{2}$ cm. and the marrow is scooped out. The tibial crest is then removed for 2 to 3 cm., so that there will be no sharp points or edges beneath the anterior flap. Sharp or rough edges, if there be any, are made smooth by rongeur or coarse file. The nerves are then carefully freed (there being five chief nerves in the leg), drawn out of the stump as far as possible, and injected with absolute alcohol as recommended by Lewis and Huber¹ (Fig. 3). The nerve is then divided just below the injected point. This prevents the formation of neuromata to a greater extent than any of the other usual methods of nerve end treatment. All

*From the Department of Surgery, University of Kansas.

¹Lewis and Huber. *Archives of Surgery*, July, 1920, vol. 1, p. 85.

bleeding vessels are then carefully ligated. The entire mass of muscle is grouped together with one strong purse-string chromic suture (Fig 4), which suture crosses over the anterior beveled portion of the tibia. Additional sutures may be placed when necessary to properly fix the muscles together. If the mass of muscle appears too bulky and is likely to produce a bulbous stump, small portions of it may be excised. The muscles should have been left long enough so that when the purse-string is drawn, the cut end of the bone will be slightly shorter than the muscle. Muscle flaps are not made. The already formed posterior fascial flap (which may have with it some of the thinned-out portion of the calf muscle tendons) is turned forward and sutured over the end of the entire stump as shown in Fig 5. The sutures placed through the flap reach well into the muscle beneath. This aids in obliterating dead space and giving the muscle a new insertion. The anterior flap is then turned down and the fascia sutured in a few places. This gives two layers of fascia over the end of the bone. The skin is then very carefully closed, shaping the flaps to fit (Fig 6). A small rubber tube drain is placed beneath the flaps. This is brought out near one end of the wound between stitches. Such drains should always be placed between sutures because healing is more prompt when the drain is withdrawn than if it enters at the end of the wound. A snug dressing is applied for the first twenty-four hours to minimize the oozing beneath the flaps. In the absence of infection some clot beneath the flap is not a disadvantage. It becomes organized and aids in the formation of a fibrous pad over the end of the bones.

After a time a bursa forms over the bone end which aids in the freedom of skin movement. The skin scar is placed so that it will not become adherent to the bone or receive pressure, thus reducing the likelihood of tenderness and ulceration. Muscle flaps are not made, nor is the muscle permitted to extend beyond the end of the bone more than 1 cm, because excess muscle produces an unstable stump end which is likely to become chafed or tender. If any pressure is exerted on muscle covering bone it promptly atrophies and is replaced by fibrous tissue. Muscle is not a normal covering for bone at points where there is weight bearing. On the other hand if the muscle is not fixed at the end of the bone it will retract, leaving bone protruding beneath the skin, which is more likely to become injured or tender than the well-rounded stump end. The above technic fixes the muscle around the end of the tibia with a purse-string and gives it an insertion both at the end of the bone and into the fascia which is sutured over it.

CONCLUSIONS

The advantages of this technic are (1) a firm rounded stump with skin and fascia freely movable over the bone, (2) a scar properly placed so it will not become adherent to bone or receive pressure, (3) no tenderness due to neuromata, chafing or ulceration, (4) the muscles have a new insertion at the end of the stump which prevents their retraction and exposure of the bone beneath the skin.

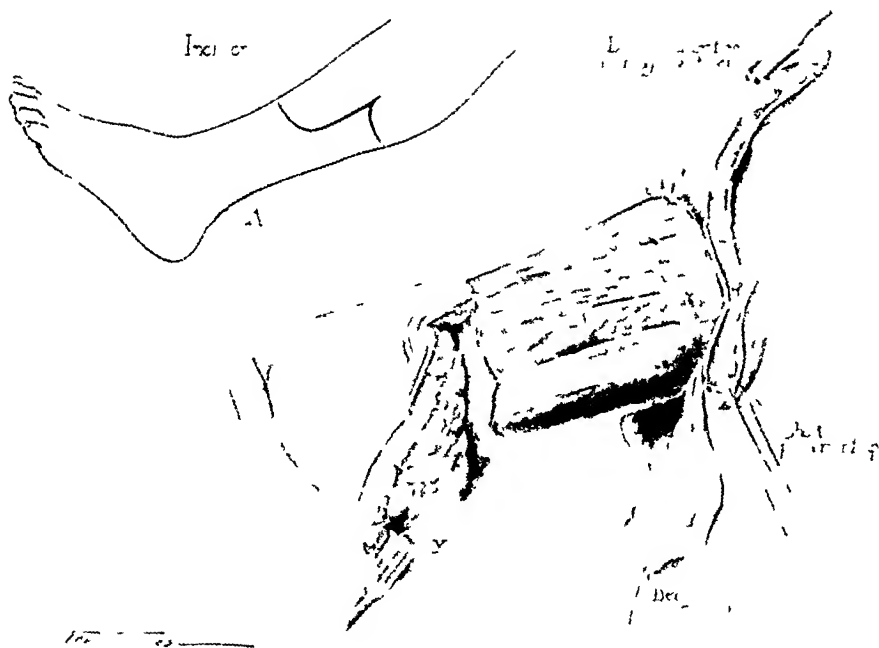


FIG 1 —Shows incision skin and fascia flaps

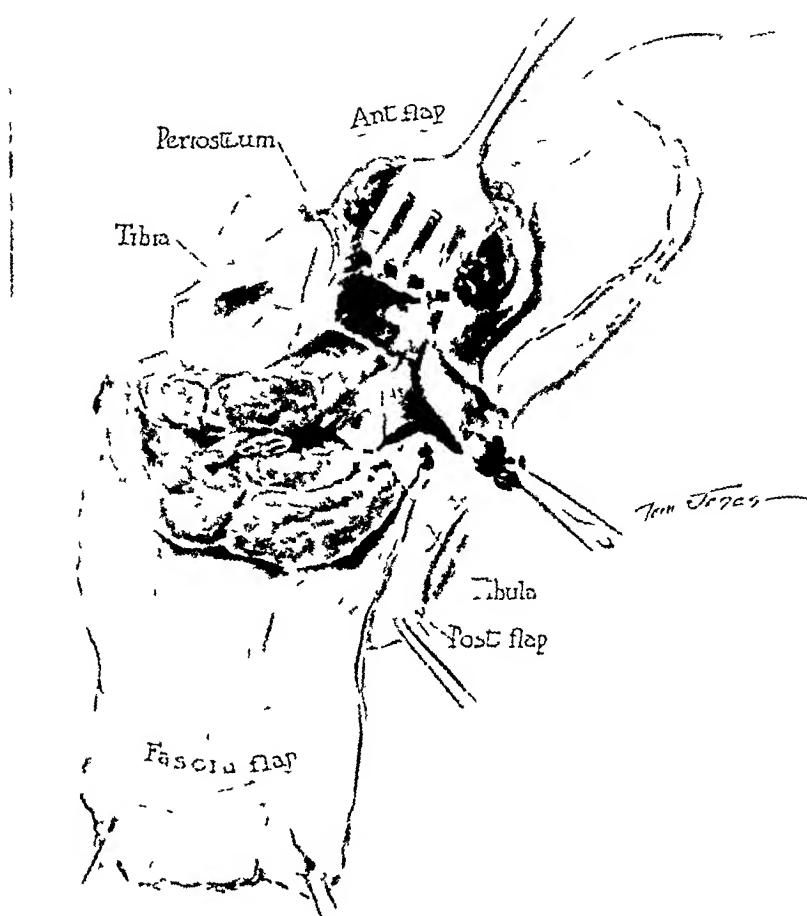


FIG 2 —Method of treating the bones and muscle The fibula is cut shorter and the muscle slightly longer than the tibia

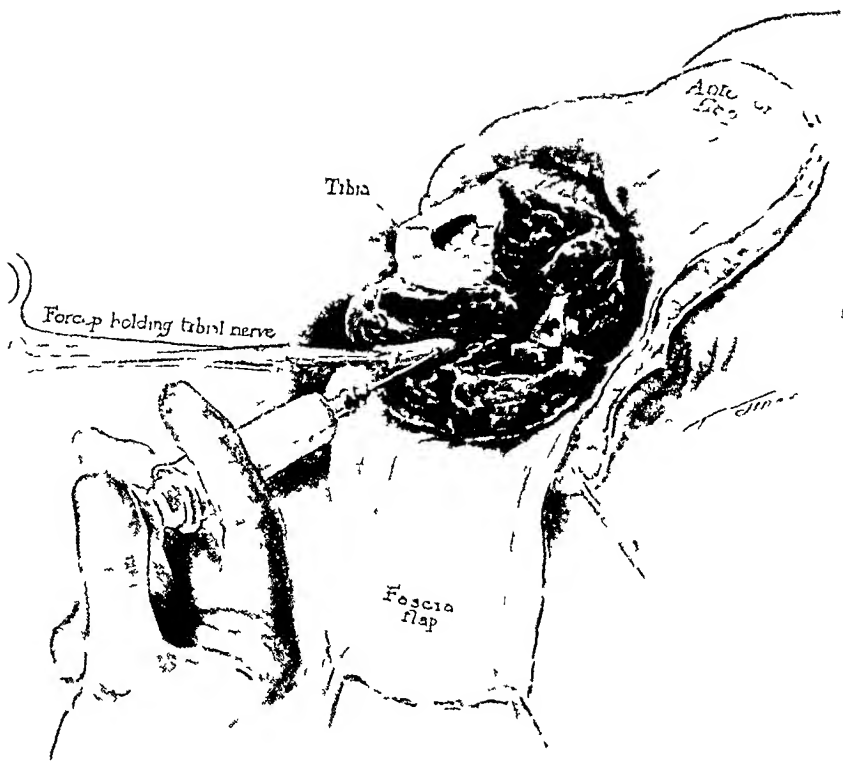


FIG. 3.—Injecting a nerve with absolute alcohol after the method of Lewis and Huber

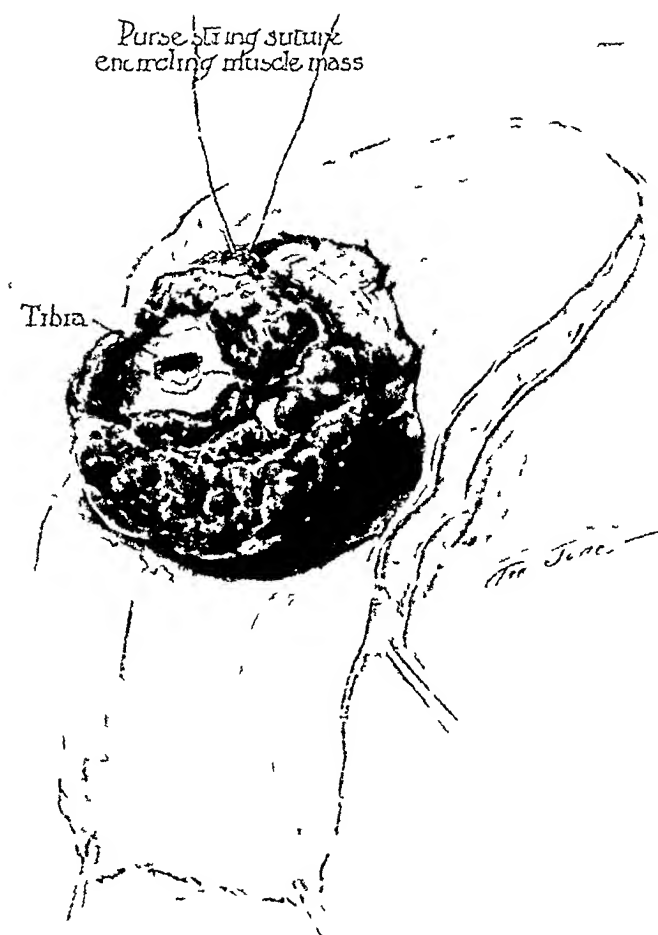


FIG. 4 —This shows the muscle grouped about the bones and held together by a heavy purse-string suture

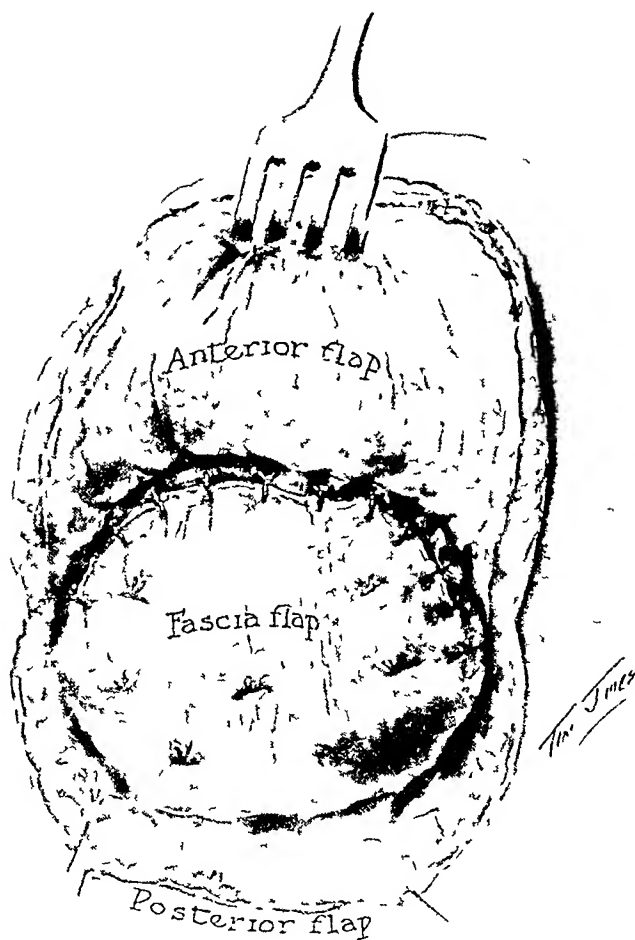


FIG 5 —Posterior fascial flap sutured over the end of the bone and muscle group
The sutures through this flap reach deep into the cut end of the muscles to fix them
firmly to the flap and to obliterate dead space



FIG. 6 —The finished stump with drain in the posteriorly placed incision

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting Held April 13, 1921

The President, DR WILLIAM A DOWNES, in the Chair

GAUCHER SPLEEN

DR EUGENE H POOL showed a woman, twenty-six years of age, who presented, first, a Gaucher spleen of unusually large size with little constitutional or blood changes, second, an unusual incision for its removal, third, it showed the advantage of ligating the pedicle before freeing the adhesions and delivering a large spleen. The chief complaint of the patient was a sense of weight in the left lower abdomen, of six months' duration. She also complained of a dull ache in the lower dorsal region and had lost thirteen pounds during this time.

Last August the patient, after a fall on left buttock, developed a tremendous hæmatoma. About this time (September 15, 1920) she miscarried (having been pregnant about six weeks). The patient thinks her abdomen "always larger than it ought to be."

On September 27, 1920, she was operated upon elsewhere for supposed ovarian cyst. The laparotomy disclosed the enlarged spleen. Nothing was done, the abdomen was closed.

Since a child she had noted an abnormal tendency to ecchymosis following slight trauma. Also extensive nose-bleeds which sometimes lasted three or four hours. The blood count January 12, 1921, was as follows: Red blood-cells, 3,800,000, hæmoglobin, 68 per cent, total white blood-cells, 3400, neutrophiles, 60 per cent, eosinophiles, 3 per cent, lymphocytes, 36 per cent, basophiles, 1 per cent, platelets, 280,000, anisocytosis, some microcytes, slight poikilocytosis. Wassermann, negative.

Physical examination revealed a mass, evidently the spleen, which reached almost to the right anterior spine and the pubis. Otherwise the physical examination was negative. The patient was well nourished, there was no conjunctival thickening, and no pigmentation of the skin.

January 25, 1921, an incision was made half-way between the umbilicus and the xiphoid, from the costal arch to the midline, cutting through the left rectus and abdominal muscles, then downward to left of the midline at umbilicus to just below umbilicus, thence outward at right angles, crossing the medial portion of the right rectus. This gave admirable exposure and the lower pole of the spleen could be lifted out of the wound. The lower part of the pedicle was lifted carefully and was ligated and cut between ligatures.

This was done for about three inches upward when it was impossible to reach satisfactorily the remainder of the pedicle, due to the fact that the firm adhesions bound the upper part of spleen and prevented its mobilization. These adhesions could not be safely broken. Clamps were placed across them and they were cut through. It was then possible to complete the remainder of the double ligation of the pedicle and the removal of the spleen, which was comparatively easy. There was some hemorrhage, however, from the upper extremity of the pedicle where a vessel had retracted. This was secured and denuded area sutured over. The wound was closed in layers without drainage.

At the end of the operation the anæsthetist called attention to the fact that there were fine petechial spots over the eyelids, conjunctivæ, face and neck and for two inches below the clavicle.

The night before the operation, Doctor Unger had transfused the patient with 500 c c of blood (direct method of transfusion). The coagulation time next morning had increased somewhat. At the time of transfusion Doctor Unger called attention to the fact that the tourniquet which had been put on a week before to examine the blood had produced marked ecchymosis. Examination showed a marked ecchymotic ring on the arm at this time (a week after the tourniquet had been applied). Examination of the patient's skin elsewhere showed that slight trauma had produced marked ecchymosis. Inquiry showed that this had been noticed by the patient herself, and the same is said to be true of her sister.

The pathological report by Dr. Ralph Stilman is as follows: The specimen consists of a greatly enlarged spleen with the vessels ligated. It is normal in shape and color and weighs intact 3080 grams. The surface is smooth and glistening and dark bluish red throughout, with the following exceptions. On the external surface near the anterior border is a yellowish area, about 5 cm. in diameter, located 4 cm. from the upper pole. This area is much firmer than the rest of the organ and appears like a thickening of the capsule, which may extend from 1 to 1½ cm. into the organ. It is irregular in outline. In the anterior border about 15 cm. from the upper pole is an indentation filled with yellowish-white firm tissue similar in color and consistence to that described above. These two areas may represent accumulation of scar tissue from an old injury or inflammation. In addition, over the external surface near the lower pole, is a white area about 6 cm. in diameter where the capsule is moderately thickened. A band of adhesions is attached to the internal border near the upper pole. The organ measures 8 x 19 x 35 cm. The consistence of the organ appears to be about normal and the capsule is not under increased tension, although the spleen is well filled with blood. When an incision is made into the capsule, a large amount of dark fluid rapidly escapes. On section the capsule is not thickened and the consistence of the organ appears normal. The cut surface is grayish red in color and smooth, and in it the Malpighian bodies are not visible. The cut surface has a smooth, finely granular appearance, which on close inspection is seen to be made up

FRACTURE DISLOCATION OF HEAD OF HUMERUS

of fine grayish points thickly scattered in a background of light red and showing a relatively small number of very fine, very dark red to almost black points. The trabeculae are not visible.

Microscopic examination showed the characteristics of Gaucher spleen. The venous sinuses are seen to be dilated and filled with large oval or polygonal, faintly staining cells, which have one or two small, somewhat irregular nuclei. These cells show a slightly striated appearance. No cells with more than two nuclei were found. The walls of the venous sinuses are moderately increased in thickness. The pulp cords are compressed. The follicles are few in number, smaller than normal, and show no germinal centres. There is no increase in the fibrous tissue of the spleen. An occasional cell contains granules of material staining with Sudan III.

Doctor Pool stated that the patient had made an uneventful recovery and was now in perfect health.

DR HOWARD LILIENTHAL stated that he had operated on one case of Gaucher's spleen and had shown the case before the Society and it was recorded in the ANNALS OF SURGERY. This patient had an enormous spleen weighing thirteen pounds, although in the laboratory without its contained blood it weighed but a little more than nine pounds. As the report of the case was published he would not go into it except to call attention to the incision which he used, and which he thought would fit practically every case. This was a sagittal incision just to the left of the midline, up to the costal border and continued to the left, close to the costal border. Through this incision you could secure the pedicle and deliver the spleen. With this incision he had never found it necessary to invade the opposite side. He thought that if he was able to get the enormous spleen out through this incision in this instance, it would fit any spleen.

Doctor Lilienthal said that this case of Gaucher's spleen which Doctor Pool had shown was the first one he had seen that did not show pigmentation. The woman to whom he had referred had generally distributed pigmentation.

DOCTOR DOWNES stated that he thought the procedure of first ligating the pedicle was the correct one when it was possible to do so. This lessened the amount of hemorrhage when the adhesions were separated.

FRACTURE DISLOCATION OF HEAD OF HUMERUS

DOCTOR POOL presented a woman, fifty years of age, who was admitted to the Second Surgical Division of the New York Hospital, March 10, 1919, suffering from a fracture of the head of the right humerus with subcoracoid dislocation.

Two hours before admission she had fallen and struck upon her right shoulder.

The X-ray showed a fracture of the anatomical neck and a subglenoid dislocated head. On March 12, 1919, open reduction was done. Anterior incision beginning at clavicle, curved slightly at the upper end and descending

between deltoid and pectoralis major Head freed and lifted into glenoid with good reduction There was a small part of the greater tuberosity attached to the head, though in general the fracture line followed the anatomical neck This portion, however, gave a good capsular attachment and probably ensured the vitality of the fragment The upper end of the lower fragment was badly comminuted, the fracture line running along the biceps groove The capsule was repaired as far as possible and the wound closed without drainage

At the end of eleven days the splint was removed, position being changed At sixteen days motion begun Twenty-one days discharged, no splint Encouraged to use arm carefully Patient was then treated in the Out-Patient Department, with baking, massage and manipulation

All motions are now normal, also the strength of arm X-ray shows that the head has atrophied only slightly

DR BENJAMIN T TILTON said that in cases of fracture-dislocation of the head of the humerus an attempt should be made to reduce the head, provided the fragments were still connected by periosteal attachments When, however, the head was completely detached and markedly displaced, removal of the head was the best procedure He recently had had two cases in which the head was displaced into the axilla and could be felt beneath the skin An incision was made into the axilla and the head removed without difficulty The functional results in these cases, while very good, were not as perfect as in Doctor Pool's case, where it had been possible to retain the head and start early mobilization

DR F S MATHEWS thought that replacing the head depended largely on the time between injury and operation In three cases, operated upon by him three to five weeks after injury, it was impossible to replace the head and the glenoid seemed largely obliterated

DOCTOR LILIENTHAL said he had had four of these fracture dislocations and the best result was obtained in one in which he was obliged to remove the head of the humerus In this case the head of the humerus lay beneath the pectoral muscle and was far from the shaft He had removed the head and the man had absolutely perfect function two years later The other day the father of a friend of his had had a fall and sustained a fracture dislocation His son, being a physician, realized the necessity of early reduction of the dislocation and had an X-ray picture taken immediately Within twenty or twenty-five minutes they found that it was a fracture of the anatomical neck of the humerus Later, another picture was taken and further details were ascertained There was a complete fracture of part of the head of the humerus and the head was split The head lay with the articular surface pointing out toward the deltoid Owing to the fact that the man was stout and heavy, it was difficult to reduce the dislocation, but he had succeeded in doing it and now, at the end of two months, the man had very good function, but not as good as in the case in which he had taken out the head The case in which the head was retained could raise

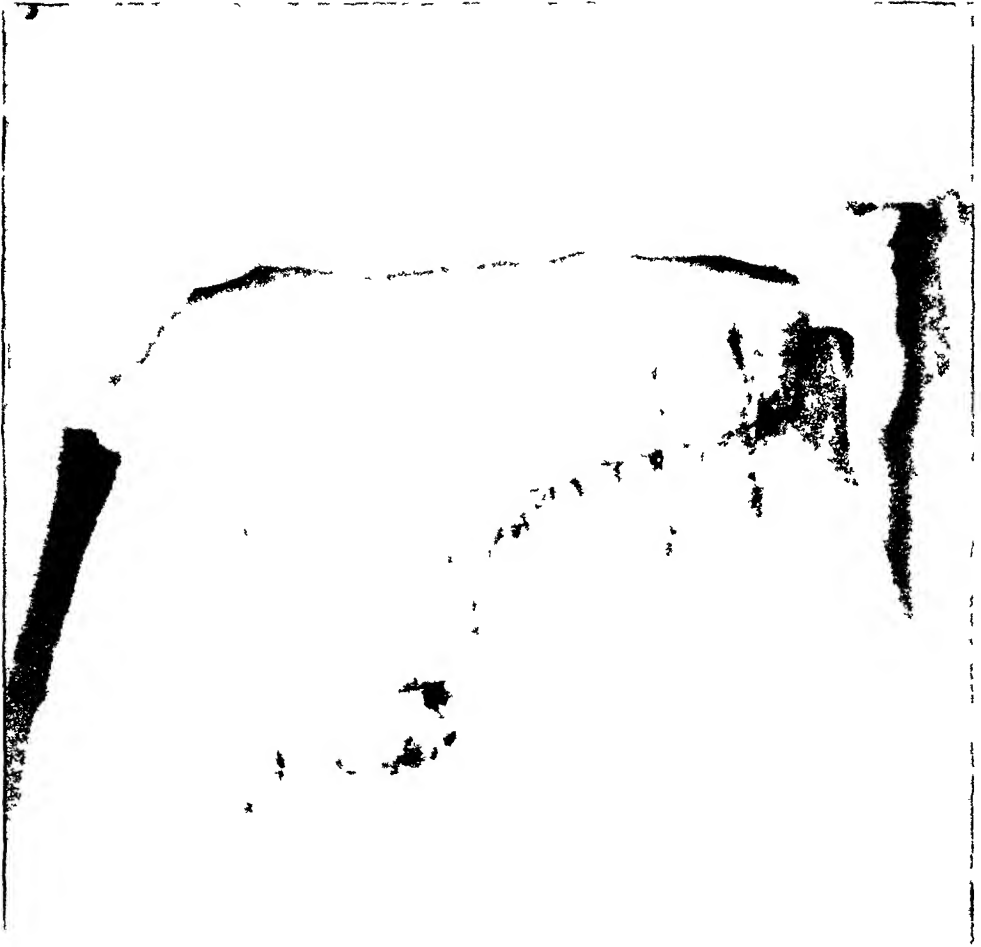


FIG 1 —Incision for removal of large Gaucher spleen about two weeks after operation



FIG. 2 —Gaucher spleen, gross section

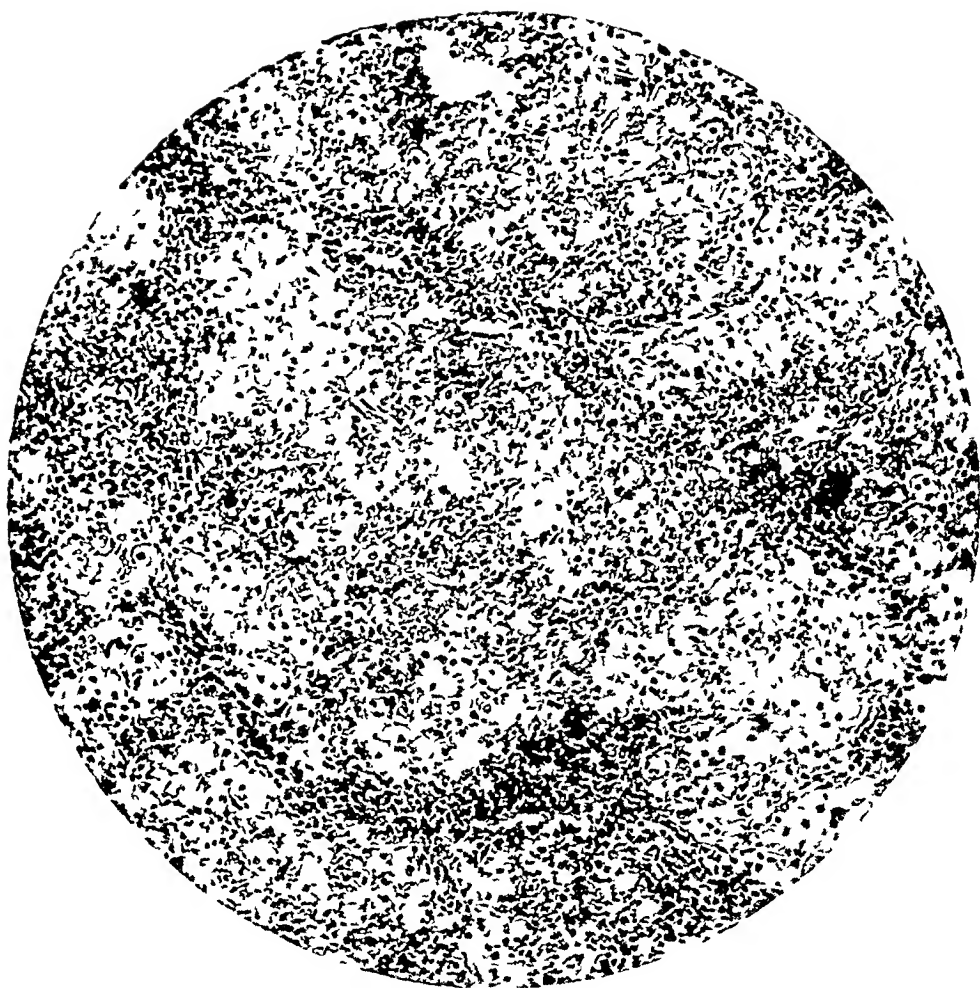


FIG 3—Gaucher spleen, microphotograph



FIG 4 —Cicatricial contraction of wrist

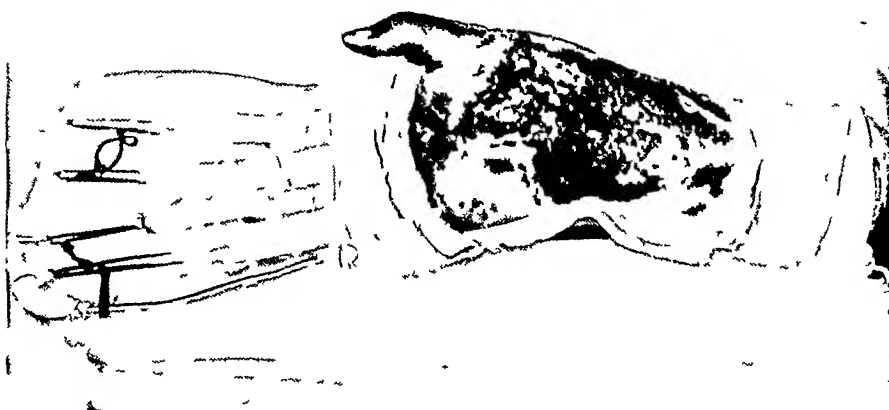


FIG 5 —Hand held in hyperextension by splints after division of palmar contractural tissue and removal of carpal bones



FIG 6 —Ultimate result obtained by effort to relieve condition shown in Fig 4



FIG 7 --Amount of flexion possible after operation in case shown in Fig 4

CONTRACTURE OF WRIST

the arm to about forty-five degrees without moving the scapula, while the one in which the head was removed had apparently perfect motion in all directions

CONTRACTURE OF WRIST

DOCTOR POOL presented this patient, fourteen years of age, who was admitted to the New York Hospital, April 14, 1920, for tuberculosis of cervical lymph-nodes and deformity of hand and wrist. He had a cicatricial contracture of right wrist resulting from a burn eleven years previously. Right hand was completely flexed at wrist-joint (Fig 4). There was very little motion in the fingers. There was also a strong keloidal band at right elbow limiting extension of forearm and a keloid with considerable deformity of lower lip. Operation, April 26, 1920. Transverse incision across anterior aspect of wrist and from this a second incision extending up the crease between palm and thumb. Scar tissue dissected out from the whole adjacent region. The wrist could not be straightened, although the soft parts were not in any way limiting it.

An incision was then made in the midline of the dorsum of the wrist, exposing the extensor tendons and the carpal bones, which were removed. The bones themselves and their relations were markedly abnormal. This wound was closed and the hand was brought up into hyperextension and splinted. Some difficulty, however, was experienced in retaining this position. After operation there was a large open area on the anterior aspect of the hand and wrist. It was planned to graft at once, but no pedunculated graft could be obtained from the vicinity and it was felt that if the part were fixed to the thorax or abdomen the wrist would certainly become flexed. It was decided therefore to defer grafting until the wound had granulated. By an ingenious splint Doctor Dineen retained extension in the wrist and fingers and yet allowed daily flexion. He dressed it with Carrel-Dakin solution, later with ambrine, and epithelialization was so rapid that grafting was not resorted to.

One month after the original operation a plastic was done for the contracture about the right elbow-joint, also a plastic on the lower lip and excision of a submental lymph-node for tuberculosis.

The wrist was treated with baking, massage and electricity for several months, getting good grip and motion in fingers with some flexion and extension of wrist-joint. The photos (Figs 6 and 7) show the result at its best. Since they were taken some flexion of the wrist has occurred. X-ray seems to indicate that this is due to excessive growth of the epiphyses. Doctor Whitman suggests excision of these and hyperextension which will probably be done.

DR ROYAL WHITMAN thought that the functional result might be improved by completely reducing the flexion at the wrist. The most effective operation would be to remove the lower extremities of the arm bones which appeared to be hypertrophied. This would destroy the epiphysial cartilage

As the patient was well developed, the additional shortening would be of slight importance compared with the increased usefulness of the hand

USE OF CHINOSOL AND SODIUM CHLORIDE AS A FIRST AID

DR WILLIAM C LUSK presented a series of patients to demonstrate the value of first-aid disinfection of civil wounds by chinosol and sodium chloride solution. He said that it seemed of significance that, out of a series of twelve experiments on dogs, in which wound pockets constructed in the subcutaneous tissue without blood infiltration, were treated first by filling with certain chinosol-salt solutions (which procedure caused lymphatic infiltration), and then by packing with gauze saturated with the solutions for fifteen minutes, before the scientific infection was instituted (the object being to create a lymphatic block with the disinfectant solution, which should completely envelop the aftercoming bacteria, having used for the infection as much of a virulent culture of staphylococcus aureus as could be absorbed on a piece of gauze about half an inch square, which had been rolled into a wad, placed in the bottom of the wound for half an hour), and then following the scientific infection, by again packing the wounds with gauze saturated with the solutions for fifteen minutes and finally suturing the wounds up tight, in seven instances primary union resulted while the control wounds suppurated with staphylococcus aureus (ANNALS OF SURGERY, May, 1919, p. 493)

It also seemed of significance that, in the case of a sterile wound pocket opened up through a three-inch long incision in the subcutaneous tissue of a dog's back, without blood infiltration, whose lymphatics had been first infiltrated with $\frac{5}{31}$ of a solution of 2 per cent chinosol and 0.85 per cent sodium chloride, which formula was that of the first-aid solution used for the past year and more, and the wound itself then packed with gauze saturated with the same solution, which was left in place for forty-eight hours, at the end of the latter period of time the gauze was found to be no more than slightly damp with moisture, and tightly adherent throughout the wound and was pulled free without causing the slightest hemorrhage, while the surface of the wound had a parched appearance and crinkled when its tissues were picked up with a forceps. The wound was thereupon again washed with the first-aid solution and sutured, the skin having been disinfected again with McDonald's solution before the packing was removed, with resulting primary union.

It seemed of significance that Dr Alexander O. Gettler, Pathological Chemist to Bellevue Hospital, had found that the chinosol-salt solutions precipitated only a negligible amount of the albumen present in blood serum.

The principles of the first-aid technic, for wounds which came early for disinfection, seemed to be, first, to remove the thin coagulum which forms on the surface of the wound, by wiping the wound with gauze saturated with the first-aid solution (a solution containing 2 per cent of chinosol and reagent sodium chloride grains $4 \frac{1}{31}$ or 0.85 per cent), so as to unstop as much as possible the open mouths of the wounded lymphatics, then to fill the wound,

if it could retain fluid, with the first-aid solution in order to encourage the latter to infiltrate the nearby lymphatics, and, in any case, to sop the wound freely with the solution, applied by means of gauze, with a view of attaining the same purpose. Then, *if the wound were capable of repair*, (1) it might be repaired at once, and closed without drainage, with the expectation of getting primary union, or, (2) it might be packed with gauze saturated with the solution, which should be covered with impervious material, and which could be left in place before repair of the wound was done, for at least as long as fifteen to eighteen hours if necessary, or probably for a good deal longer. In either instance the first-aid solution should be used freely in the wound during the operation for repair, and the wound closed without drainage. If the effectual action of chinosol in wound disinfection were due to its stimulation of phagocytosis, as seemed likely, since *in vitro* chinosol was but little bactericidal, drainage would only impede this physiological process. *If the wound were not capable of repair*, it should be treated open, being filled with gauze saturated with the first-aid chinosol-sodium chloride solution, which dressing might be removed once a day, or, if the gauze became adherent, then after a longer interval.

In the case of traumatic wounds widely contaminated with foreign material, as wounds of war, *which came late for first-aid disinfection*, at a time when the implanted bacteria had begun to multiply, it seemed to be a question whether it would be desirable to attempt more than a mechanical cleansing of the wound, and packing of the same with gauze saturated with the first-aid chinosol-sodium chloride solution, omitting any attempt to infiltrate the lymphatics with the latter, lest the attainment of such purpose might then become a means of spreading the infection, as had occurred in a number of freshly made experimental wound pockets in dogs, in which the scientific infection had preceded the infiltration of the lymphatics with the disinfectant solutions, suppuration which extended to a distance from the original wound having frequently resulted.

CASE I—W J McI, aged twenty-eight *Incised wound of nose and cheek*. Admitted to Bellevue Hospital December 12, 1920. The incision cut obliquely through the left nostril, passing in the median line just above the tip of the nose, entering the right nostril and completely severing the nasal septum, then, cutting through the junction of the right ala with the cheek, it passed backward and a little downward across the right cheek for a distance of about four inches, at which latter situation it was about three-quarters inch deep. There had been free hemorrhage into the wound from a severed facial artery. There was no evidence of iodine having been used. On admission, after arresting the hemorrhage and wiping the skin with the solution of Dr. Ellice McDonald (alcohol sixty parts, acetone forty parts, to which mixture 2 per cent of pyxol is added) [McDonald, Ellice *Journ Amer Med Assn*, February 7, 1915, vol lxiv, p 505, and *Surgery, Gynecology and*

Obstetrics, July, 1915, pp 82-86], the solution of 2 per cent chinisol and sodium chloride, grs 4 I-51, was poured into the wounds, which were then packed with gauze, saturated with the same solution, and this dressing was covered with rubber tissue

Nine hours later the wound was examined and redressed as before, and one hour afterward was repaired. The tissues of the wound had preserved a perfectly fresh appearance and showed no chinisol staining (The first-aid solution may combine with infiltrated blood to produce a gray or black stain of the tissues, which does not interfere with primary healing in a sterile wound). Skin preparation was first by wiping with peroxide of hydrogen and then with ether to remove the blood clots, etc., then, for disinfection, by wiping with McDonald's solution. The wounds were wiped and sopped with the first-aid chinisol-sodium chloride solution, and the latter was poured into the wound of the cheek and used freely in the wounds during the operation for repair. Three deep catgut sutures approximated the fat of the cheek, while the skin was sutured with horse-hair. The sutures in the nose, which were deeply placed, did not bring the skin edges evenly together. The nostrils were packed with gauze wet with the first-aid solution and the stitch-line was covered with the same dressing, having rubber tissue superimposed. The wounds were dressed daily as above. The highest temperature following operation was 100 degrees. A primary swelling of the cheek reduced rapidly (fourth day). With the exception of two slight openings in the suture line of the cheek wound, from which a few drops of serum discharged on the second, third and fourth days, and a little ulceration along three or four stitches in the same wound, which were mere tacks in the skin edges, primary union took place throughout. The ragged line of union in the nose under the wet dressing with the first-aid solution, applied once daily, rapidly cicatrized and skinned over. The patient was discharged from the hospital on the eighth day, he returning for a few more dressings of the wound of the nose.

CASE II—J B, age twenty-four. *Incised wounds of neck, pinna and face*. Admitted to Bellevue Hospital December 27, 1920. Transverse incised wound of back of neck, about one inch below level of occiput and about four and a half inches long, extending from just behind the right ear to the left of the median line, cutting across the ligamentum nuchæ and completely through the adjoining one and a half inches of the right trapezius muscle. Also, in the same line, the right pinna was entirely cut through and there was a superficial incised wound of the right cheek about one and a half inches long. No iodine or other chemical had been used in the wounds prior to admission. A nicked occipital artery had bled freely into the wound. Though the skin around the wound had been wiped early with McDonald's solution, the hair of the scalp was not shaved until just before the operation. The wounds were washed with the solution of 2 per cent chinisol and sodium chloride, grs 4 I-51, and then packed with gauze saturated with the same solution. Twelve hours later the wounds were examined. That of the neck was filled with the first-aid solution and all the wounds

USE OF CHINOSOL AND SODIUM CHLORIDE AS A FIRST AID

were repacked with gauze saturated with the same solution, overlapping the skin edges

Operation for repair thirty-one hours after the first-aid solution had first been used in the wounds. The wounded tissues at this time were fresh and moist and normal in color, and without a particle of chinosol staining. The skin was cleansed of its blood stains by wiping with peroxide of hydrogen and afterward with ether, was shaved and then disinfected with McDonald's solution. The first-aid chinosol-sodium-chloride solution was used freely in the wounds. The wound of the trapezius was sutured with interrupted chromic sutures, the skin of the neck with silkworm gut and the wounds of the ear and face with horse-hair. The wounds were dressed with gauze wet with the first-aid solution, which was covered with rubber tissue. Uneventful recovery. Primary union throughout.

CASE III—T. L. O'D. Electrician. Age about twenty-two. This case illustrates the open first-aid treatment of wounds unsuitable for primary repair. It was one of *high compound fracture of the leg with gangrene of the foot*, in which suppuration did not occur in the wound, treated open with the first-aid chinosol-sodium chloride solution then in use (chinosol, grs. iv- $\bar{5}$ i, and normal sodium chloride), so that it was possible on the fifth day to amputate at the seat of fracture and ultimately to save the knee-joint.

On March 12, 1919, the patient was admitted to Bellevue Hospital after having sustained a compound fracture of the left leg about four inches below the knee-joint, with much laceration of the soft parts, there having been a widely separated wound anteriorly, and the finger passed backward between the bony fragments, entering an area of deep laceration behind the seat of fracture. The foot was lifeless. There had been no iodin or other chemical introduced into this wound prior to the first-aid dressing with gauze saturated with a solution of chinosol, grs. iv- $\bar{5}$ i, and 0.85 per cent sodium chloride, the first-aid solution in use at that time, which was laid in the interior of the entire lacerated area, having been introduced through the seat of fracture, into the wounded soft parts behind. Two strips of gauze, introduced at the first dressing, became so tightly adherent in the deep wound that they could not be readily detached until the fourth day. When removed they were odorless. The wound was dressed once daily. On the second day, all the gauze that was detachable was removed, the wound cavity was filled with the first-aid solution and fresh gauze wet with the latter was introduced. On the third day, all loose pieces of gauze were removed. Some of the gauze applied to the superficial wound on the preceding day had become adherent. The gauze withdrawn was perfectly sweet and there was no pus in the wound. The deep wound was now filled with the first-aid solution and gauze wet with the latter was simply laid over the superficial wound and was covered with rubber tissue. The temperature was not over 100.4° until the fourth day, when it rose to 102°. On the fifth day amputation of the leg was performed, which was done through the seat of fracture, making a long

posterior flap, including muscle which was the seat of thrombi, though the posterior tibial artery in the flap pulsed. A personal note on the operation stated "The wound contained a little serosanguinolent discharge." Following the amputation, the interior of the wound sloughed, and to facilitate the removal of the sloughs, gauze saturated with a solution of 2 per cent chinisol and 5 per cent sodium chloride, was applied to the wound once daily. (Caution was recommended in the use of the latter strongly hypertonic solution on tissues affected by senile or trophic changes.) On the eleventh day post-operative, a slough of the calf muscle, half the size of a fist, had almost separated and was removed by cutting a few remaining attachments. On the fourteenth day, after finally washing the wound, which was now practically free from sloughs, with the same solution, the posterior skin flap was laid forward against the granulating surface behind the tibia and a compress applied, and on the following day the apposed tissues had adhered nearly everywhere. The tibial fragment protruded.

On April 23rd reamputation was performed, the line of dividing the bones being through the lower portion of the tubercle of the tibia and through the middle of the head of the fibula. A solution of 2 per cent chinisol and 0.85 per cent sodium chloride was used in the wound during the operation. The wound was closed with drainage and primary union occurred in all of the apposed tissues and the drain sinuses rapidly closed. The middle of August, 1919, the patient began wearing an artificial leg. Three months later he stated that his artificial leg had never given him any trouble, that his stump had never swelled and that he was on his feet all day long. Since then the patient has had no trouble, climbing ladders with ease in the routine of his work.

DOCTOR LUSK said that he believed this open first-aid treatment would be applicable as well to the *wounds of war*, in which a gauze packing, saturated with the first-aid solution (2 per cent chinisol and sodium chloride, grs 4 i-5 i), and covered with impervious material, at least could be expected to arrest bacterial growth and prevent decomposition for a considerable period of time.

The first-aid solution was made with *cold* sterile distilled water, in which 2 per cent of chinisol powder should first be dissolved, and then *reagent* sodium chloride, grs 4 i to the ounce (0.85 per cent), which should be added in bulk. In making up this solution the glass receptacles and utensils should first be scoured with neutral sodium oleate and then boiled in plain water. An alkali would precipitate oxyquinolin from the chinisol (oxyquinolin sulphate), so that soda should not be put into the water used for boiling. A glass vessel was preferable to an enamelled one as a container, since spots of bare iron usually present in the latter receptacle, would discolor the chinisol.

The addition of the sodium chloride to the chinisol in solution, changed the microscopic picture of the crystallization of the chinisol and was believed

to render the latter little liable to irritate. A solution of 2 per cent chinisol in combination with normal sodium chloride had seemed liable to irritate only from too oft repeated applications daily, or from a too long-continued use of the applications once daily on gauze left *in situ* between dressings, in the latter instance the skin alone being usually affected, the wound apparently being protected by dilution of the solution with a sufficient amount of secretion. The solution on first coming into contact with a wound caused a burning sensation for a few moments. The "reagent" sodium chloride had seemed to produce more completely the changes in the crystallization of the chinisol than had less pure varieties of sodium chloride. Boiling of the sodium chloride had seemed to produce salt cubes, as seen under the microscope in the crystallized specimen, generally larger in size and fewer in number than when the sodium chloride was added to the solution without boiling, the finer subdivision of the cubes of the unboiled product apparently acting more widely throughout the solution to cause the change in the crystallization of the chinisol. The chinisol-salt solutions should not be boiled, since when boiled they caused a greatly intensified burning sensation in the wounds and had seemed liable to produce a superficial tissue necrosis.

Grains xxiv of chinisol in solution had been infiltrated into the lymphatics around a sterile subcutaneous wound pocket, free from blood infiltration, in the back of a dog weighing 8 kilos, with primary union in the sutured wound and without subsequent ill effects.

DR ROBERT T MORRIS asked Doctor Lusk whether the use of the isotonic saline solution allowed him to use a stronger chinisol solution without causing irritation than would be possible otherwise. He stated that he used chinisol solution in about the same proportion as bichloride of mercury. Used in that way, he found that a 2 per cent solution of chinisol was sometimes irritating, and he had depended chiefly upon less than 1 per cent in solution without salt. It was one of the best antiseptics for all around convenience.

DOCTOR LUSK, in answer to Doctor Morris' question, said he believed that the addition of the sodium chloride in normal strength to a solution of 2 per cent chinisol, which changed the form of crystallization of the latter, made the solution of this strength of chinisol less liable to cause irritation. In the first-aid treatment of fresh traumatic wounds as described, the speaker had seen no evidence of chinisol irritation. Where sterilization of abscess cavities was sought by the daily introduction into them of a gauze packing saturated with the first-aid solution, left in place between daily dressings, wound or skin irritation had not been seen. In general terms, a sufficient amount of wound secretion had seemed to be protective against the production of wound or skin irritation as a result of the application of the solution of 2 per cent chinisol and normal sodium chloride on gauze left in place between daily dressings, and where the wound secretion was ample, it had seemed that this wet dressing could, as well, be confined beneath an impervious covering with impunity. In the case of small wounds without much secretion, an external dressing saturated with the first-aid solution, renewed

once a day, might, after a little while, irritate the skin, it being particularly liable to do so when confined beneath an impervious covering, which latter should generally not be used on these cases. At the same time, a first-aid wet dressing applied once a day to an illy-apposed suture line, had, in a number of instances, caused rapid healing of the ragged edges. But two wounds, ones of long standing, had seemed to have become irritated from the application of the first-aid solution once daily, to one of them (thrombo-angitis) the application having been made for only a short period of time each day, in the other, the packing wet with the solution having been retained between daily dressings over a considerable period of time, and each discharging but little secretion. Granulating wounds with but little secretion had sometimes been syringed with normal saline before packing them with gauze wet with the first-aid solution, which technic had seemed to be favorable to healing.

CARCINOMA OF THE RECTUM

DR HUGH AUCHINCLOSS presented two methods of dealing with rectal anastomoses after removal of carcinomata. The carcinoma was four and a half inches above the anus in one, and at the promontory of the sacrum in the other. Both were "high" cases. If one classified cancer of rectum cases as high, low, and medium, these would be medium and high.

Low cases, within two or three inches of the anus, are best dealt with by a colostomy. Occasional cases remain well in this group after having had an anastomosis done, but it is pretty generally conceded that the colostomy and complete removal of rectum is safest.

The middle group is where an anastomosis can be effected, though done with difficulty because of the shortness of the anal segment.

The high group is where sufficient anal segment has been left to allow of an anastomosis through the abdomen.

The blind procedure of removing a carcinoma of the rectum entirely from below without knowing whether metastases exist above is falling rightly more and more into disrepute.

CASE I—G S, male, thirty-five years of age, single. Ship steward, Swede, M U S fifteen years. The previous and family history were irrelevant. Admitted to Presbyterian Hospital August 25, 1919. Entered U S Army February, 1918, *i e*, eighteen months previously. Eight months ago fell two flights to a stone pavement, couldn't walk for a month, in bed, bruised and strained lower back. At same time began to have diarrhoea, cramps and colic. Six months ago bleeding from rectum. Four months ago constipation, pain in sacral region, and at about this time was discharged from the Army. Some loss of strength. Lost ten pounds. No vomiting nor bladder symptom.

Proctoscope and Digital Examination—Hard, nodular, ulcerating growth of characteristic cauliflower appearance involving anterior wall, most of left and a little of right sides of rectum, four and a half inches

above anus Specimen removed, reported carcinoma of rectum Operation September 3, 1919

Pathology of growth as described in examination, free from bladder, and covered by peritoneum except posteriorly, where mesorectum broadens out to either side Mesosigmoid was short and sigmoid also No evidence of metastases, lymph-node nor liver

Procedure Median incision below umbilicus Superior hemorrhoidal clamped close to inferior mesenteric and half the sigmoid removed and oral end inverted with a purse string, the ends of which were long and threaded through the loop in a probe The rectum was then freed well below the growth and a heavy silk ligature tied about the rectum an inch below the growth With the patient in lithotomy position, Doctors Burnap and Hanford, who were good enough to assist me, working from below dilated the sphincter and washed the rectum clean as far as where the ligature had been placed below the growth, preventing feces and blood from the ulcerating carcinoma from running down They then introduced a glass, Ferguson, cylindrical speculum almost to where the ligature had been placed Eight long five-inch needles, that had been specially made for this purpose, threaded on either end of silk sutures, were then passed, interlocking as chain sutures, two needles close together at each of the four quadrants of the gut circumference, about an inch below the ligature through the wall of the gut from above, into the speculum in the interior of the rectum below and drawn out of the anus Traction on all these ligatures pulled the wall of the rectum over the edge of the speculum The gut was then divided by the operator above, about two inches below the growth and one inch below the ligature, and the growth, one-half of the sigmoid and upper two-thirds of the rectum removed By pulling the traction sutures the lower anal segment was then turned inside out into the speculum and the speculum and anal segment drawn out of the anus Some confusion occurred here because the sutures had not been kept in the four quadrants to which each pair belonged

The probe attached to the purse string about the end of the oral segment was then passed through the lower anal segment that had been turned inside out, and the oral segment, namely, upper sigmoid, which previously had been mobilized further by dividing the outer leaf of the peritoneum over the descending colon, drawn through for about six inches Anastomosis was then done with interrupted chromic sutures and a tube introduced through the sigmoid to just above the anastomoses The sigmoid, and "turned inside out," telescoped, lower segment was pushed back through sphincter, leaving some of sigmoid and the tube protruding A lateral incision into ischiorectal space posteriorly and along the coccyx was made for drainage

Pathological report, carcinoma of rectum

Seven days later developed a fecal fistula—tube and sigmoid slough removed on ninth day Bowels moving, however, through anus Twenty-eighth day fistula almost closed Discharged forty-second day to Burk's Foundation Stayed there ninety-two days, being employed

most of the time as one of their cottage leaders Fistula entirely closed
Shortly after discharged from the hospital

There have been forty follow-up observations since discharge up to the present Proctoscopic examination has been done repeatedly by Doctor Yeomans His bowels move satisfactorily according to his diet and he is now taking a course in vocational training and seems quite well There is a slight weakness of the lower end of the median incision where the drainage tract and fistula was situated, but the mucosa of the rectum shows no evidence of recurrence and only moderate constriction

CASE II—M F, female Ireland Age fifty Admitted to Presbyterian Hospital March 7, 1919 History Double oophorectomy thirty years ago at Woman's Hospital Recent loss of weight of thirteen pounds Slight amount of blood in stool several months ago Thought she had hemorrhoids Since then stools occasionally "almost black" Feels strong and well Bowels have been moving regularly, no diarrhoea Comes to hospital because one week ago she had an acute attack of "inflammation of the bowels," with gas, colicky pains, and maximum "soreness" and tenderness in left lower quadrant radiating to her back Nauseated, but couldn't vomit Slight febrile reaction

Examination Well-nourished woman not appearing ill, with a median scar below umbilicus from old operation In left lower quadrant just to left of promontory there seemed to be a mass that was very slightly movable and a little tender No visible peristalsis, no mass felt by rectum Proctoscope could not be passed beyond ten inches and no abnormality of mucosa made out at that point

It was only after three X-ray examinations that a filling defect was defined at the junction of rectum with sigmoid Gallstone shadow definitely shown The diagnosis of carcinoma of pelvic colon was made, having in mind a diverticulitis or ileus from a peritoneal or omental band, a sequel to former operation She also was thought to have chronic cholecystitis, cholelithiasis, calculus in gall-bladder Operation March 31, 1919

Pathology A large mass, evidently an annular carcinoma of the colon at the junction of the rectum and sigmoid, lay just to the left of the sacral promontory at the brim of the pelvis There were peritoneal adhesions binding two loops of small intestine to the growth Evidently a recent localized peritonitis had occurred about the growth The sigmoid was only moderately distended, whereas the rectum below the growth was very markedly distended, a feature not uncommon in such a case

Procedure The small gut was carefully dissected free from the growth The mesentery was ligated off and growth and about 8 cm of gut above and about the same amount below removed in following manner Four crushing clamps were placed above and below, and gut divided between them with a cautery The cauterized ends were then placed end to end, and rolled away from one another so that two continuous crushing sutures of silk could be placed, uniting the serous

surfaces of the two segments for half their circumferences. The clamps containing the cauterized ends were then rotated over so as to bring the other halves of the gut circumferences together, and the two already placed sutures complete the gut circumference back to the point they started from. The clamps were then loosened and slipped off and the sutures tied, first the inner layer, then the outer layer, thus completing the anastomosis. The closure seemed quite complete, and fingers could readily be approximated on invaginating the gut wall from above and below. Rubber tube drains were placed alongside the anastomosis into the pelvis. A rectal tube was left in rectum temporarily, in case there should be any bleeding from mucosa edges.

Post-operative course This was unexpectedly smooth. There was no fecal leakage at any time, no hemorrhage, temperature 101° on second and fourth days and below 100° at all other times, pulse never above 100 after operation. She was discharged April 30, 1919, on her thirtieth day after operation, with only a tiny granulating spot that readily closed.

Follow-up notes Twenty-nine reports have been made and to-night makes the thirtieth time I have seen her during the period of two years since the operation. She has been proctoscoped twelve times. The proctoscope passes through the anastomosis, which appears as a slightly paler portion of the mucosa, readily into the sigmoid. The rather conspicuous absence of stricture is worth consideration. On March 22nd she weighed $131\frac{1}{2}$ pounds, which is more than she has weighed at any time since her operation, her bowels move readily, and as far as we can tell she seems perfectly well.

This is the first time he had used this method for an end-to-end anastomosis of the large gut, though he had used it a few times for end-to-side ileocolostomies. It has never been associated with hemorrhage. It is the cleanest anastomosis I know of that works. Furthermore, it is simple. He first saw it used by Doctor Blake several years ago in an ileocolostomy, end-to-side, following resection of carcinoma of cæcum. The method is not original. The purpose of showing the case is to call attention to the method for large intestinal anastomosis where scrupulous asepsis is of such prime importance.

DOCTOR HARTWELL said that the second case looked as though the carcinoma had been situated only about two inches above the line of section of the rectum. He had always felt that if a carcinoma was low enough to be reached by the palpating finger no one could predicate a cure by end-to-end anastomosis. This boy seemed to be cured at the present time and he might remain free from recurrence. It seemed to him that to leave the amount of rectum necessary in order to have the sphincter function was sometimes a dangerous procedure. Of course that did not apply to a growth situated higher up. One or two cases in which a low end-to-end anastomosis had been done showed a long period of cure, but a number of cases collected showed a large percentage of recurrences at the site of the anastomosis. Doctor Hartwell said he had come to believe that if a cancer lay below the

peritoneal reflexion it was better to sacrifice the lower segment of bowel and to make an artificial anus

DOCTOR AUCHINCLOSS rejoined that these growths were above the peritoneal reflexion. In the second case when the bowel was pushed down, one could barely palpate the lower margin. He had seen a patient who had an extensive growth with involvement of the lymph-nodes in 1913. In this instance the growth was not over an inch above the anus and the patient was well to-day. However, he agreed that the lower growths had better be taken out with the sphincter. These two growths were both high growths. He had used this method of anastomosis with clamps for end-to-side anastomosis. Small gut into large in resection of cæcum. With this method one did as nearly as possible an aseptic operation. The only mucosa exposed was that that had been cauterized. This was the only case in which he had done an end-to-end anastomosis of the large intestine by this method. No leakage following operation and no stricture two years later in this case give hope it may prove useful in others.

LUMBAR HERNIA

DOCTOR COLEY showed a man, aged twenty-five years, suffering from a double lumbar hernia. He had served in the United States Navy in the late war, and gave a history of having had a hernia just between the iliac crest and the costal arch on both sides for some years, which only recently began to give him trouble. The bulging was more noticeable on standing or lifting, and violent exercise of any kind caused considerable pain. He was admitted to the Hospital for Ruptured and Crippled in 1919, where Doctor Coley operated on the left side, which was a little larger than the right. The operation consisted of a three and a half inch oblique incision, one and a half inches above the crest of the ilium, extending back to quadratus lumborum, no sac was found, the peritoneum was not opened and closure was made by overlapping the suprapubic layers of muscles. The opening through which the protrusion occurred was apparently located in the space known as the triangle of Petit. The patient reported for duty three weeks after leaving the hospital, and had to sleep in a hammock, where he was tossed about. A recurrence of the hernia developed and it is now nearly as large as the hernia on the other side. At the present time there is a distinct bulging through Petit's triangle, which, as you know, is situated between the outer border of the latissimus, the posterior border of the external oblique, and the crest of the ilium. Doctor Coley remarked that this type of hernia is extremely rare, the latest study of the subject having been made by Goodman and Speese (ANNALS OF SURGERY, May, 1916), who reported one case in a man, fifty-eight years of age, in which on account of a coexisting nephritis no operation was performed. They were able to collect thirty-three cases of lumbar hernia from the literature.

This type of hernia was apparently known as early as the latter part of

the seventeenth century, but no careful observation was recorded until that of Garangeot in 1731. In 1768 Balin writes "Lumbar hernia may arise unexpectedly between the false ribs and the crest of the ilium." A few years later, Petit described the same place in a little more detail, and to him the credit is generally given for the discovery of this triangle known as Petit's triangle. Grynfeldt, in 1856, describes the place still more fully. Grynfeldt's space is a little different from Petit's, it is bounded above by the twelfth rib, internally by the quadratus lumborum, externally by the external oblique and below by the internal oblique muscle. Four years later, Lesshaft, without mentioning Grynfeldt's work, described the same space, and it is generally known in Germany as Lesshaft's triangle. (For a full description of the condition, see Goodman and Speese's original article in the ANNALS OF SURGERY, May, 1916.)

Of the thirty-three cases collected by Goodman and Speese, intestinal obstruction with strangulation occurred eight times, or in 24 per cent of the cases. In nineteen cases the hernia was on the left side, and in ten on the right, only two were bilateral. It was much more common in adult males, having been observed twenty-two times, and only nine times in females.

Doctor Coley stated that as far as he knew only two cases had been observed at the Hospital for Ruptured and Crippled, one a girl, aged eight years, who was operated upon by Doctor Bull and Doctor Coley in the early 90's, patient made a good recovery and was without recurrence for many years after. The present case is the only case of bilateral lumbar hernia that they had ever observed, and apparently only two other cases have been found in the literature. Goodman and Speese state that indirect traumatism is an important causative agent, a history of sudden strain, lifting of heavy weights, and coughing, has been noticed in fourteen of the thirty-three cases. As regards the age of their patients only five occurred before the fortieth year. Both of the cases observed by Doctor Coley occurred in patients under thirty years of age. In most of the cases mentioned no sac has been found either at operation or autopsy.

DR ALEXIS MOSCHCOWITZ stated that he had examined the patient only hastily, but as thoroughly as it was possible for him to do at this time, and he could not quite see where this hernia came through. As a matter of fact, without wishing to doubt the diagnosis in the slightest degree, he must say, that he did not understand the method by which the diagnosis was arrived at. Cases of this nature are exceedingly rare, but from a study of the literature, he was under the impression that of all hernias in this region those that passed through the triangle of Petit are the rarest, indeed the occurrence of this particular variety was a matter of doubt, an authentic and well-studied case was, however, reported a few years ago by Dowd in the ANNALS OF SURGERY. Those hernias which pass through the space of Greenfelt and of Lesshaft appear to be somewhat more frequent, though by no means common. Doctor Moschcowitz would not wish to express any definite opinion as to the case.

presented by Doctor Coley, after the meagre examination that he was able to make

DOCTOR COLEY rejoined that hernia of this region had not always been accurately classified, it having been the custom to include under the name of lumbar hernia all hernias occurring between the crest of the ilium and the twelfth rib. Possibly they did not all come out at the triangle of Petit. Doctor Coley stated that in the present case he believed the hernia to emerge at or near Petit's triangle, for if the hand were placed over this space, the swelling did not appear. After emerging, it passed inwards and downwards so that the swelling was slightly more anterior than in the cases observed by Goodman and Speese. Doctor Coley believed these hernias were properly classed as lumbar hernia. He said he should like to ask Doctor Moschcowitz through what opening the hernia did come out if not through the triangle of Petit. Doctor Moschcowitz stated that he did not know. Doctor Coley added that there was a bulging through the whole area at the site of both Petit's triangle and Grynfeldt's space. It was not always easy without operation to give the exact anatomical location.

THE MANAGEMENT OF PELVIC ABSCESS IN ACUTE APPENDICITIS

DR ELLSWORTH ELIOT, JR., read a paper with the above title.

DR ALEXIS MOSCHCOWITZ said that he was glad to hear that Doctor Eliot does not advocate the drainage of pelvic abscesses through the rectum or vagina, at the time of the primary operation. Doctor Moschcowitz has found that it is not only feasible, but perfectly safe and simple to drain these abscesses through the incision which is made for the extirpation of the appendix. He uses as drainage material always a good-sized drainage tube, with a wick of gauze in its lumen. This wick of gauze is removed at the end of twenty-four or forty-eight hours. If there are two widely separated collections of pus two drainage tubes are used. The after-treatment differs somewhat from that advocated by Doctor Eliot. He has abandoned all irrigations, after an experience many years ago, at which a fatal peritonitis developed after a gentle irrigation through a catheter. The method he now uses is, that the drainage tube is cleansed by passing into it repeatedly wicks of gauze until perfectly dry, this is done at each dressing, usually once a day. When the discharge assumes a more serous character, the tube is shortened by one-half to one inch, until removed completely. With this method of after-treatment his results have been most satisfactory, most patients being discharged with a healed wound in two weeks' time.

In very rare instances, more especially in some cases of diffuse peritonitis, late residual abscesses form, *e g*, in the subphrenic space, in the left iliac fossa, or in the splenic region, and require separate incisions. If they occur in the pelvis they are drained either through the vagina or through the rectum, but never as a primary procedure.

DOCTOR HARTWELL said he used a double soft drain or a cigarette drain. He left it in forty-eight hours.

THE MANAGEMENT OF PELVIC ABSCESS IN ACUTE APPENDICITIS

DR WILLY MEYER recalled that about ten years ago the question came up whether surgeons should close the abdomen without drainage after appendectomy in cases where a pelvic abscess or multilocular effusion of infected fluid had been found subsequent to acute gangrene, the latter not having passed from the appendix to the cæcum. Many tried this method and closed the wound, and while it was successful in a good many cases it had been given up as uncertain and drainage generally employed. One could not determine always how far the gangrene had actually extended. He used the pararectal incision and was still using Morris's cigarette drain with a central tube. He sometimes added a rubber tube split lengthwise after all the pus had been evacuated. Personally, he never used irrigation but he always added post-operative posture treatment, using the pronounced Sims posture combined with the Fowler position. After the first three days a slight Trendelenburg posture was resorted to.

In operating upon an acute case he believed it was an unwise procedure to make an abdominal incision with a vaginal or rectal incision. One certainly could reach a deep-seated abscess through the abdominal incision, but if a pelvic abscess developed slowly following an acute attack of appendicitis, say eight to ten days after, without perityphlitic inflammation and swelling, one could make the diagnosis by rectal or vaginal palpation and then evacuate the abscess through the rectum.

DR WM T LUSK said it had been scientifically shown on rabbits by Petroff, of Warschau (*Centralblatt f Chir*, No 31, 1913, p 1215), that glass drains with wicks were the best for peritoneal drainage, since adhesions were very slow to form around glass, and a drain of this sort would continue to abstract fluid out of the general peritoneal cavity for more than forty-eight hours, while gauze was effectual to drain for only five to six hours. He thought that in acute general peritonitis, pelvic drainage was best effected by the old-fashioned glass drain with multiple perforations in it, threaded with a gauze wick to the bottom. In the Fowler position, the lumbar spine should be arched well forward in order to empty fluid collections out of the kidney fossæ into the pelvic cavity, which posture seemed to be best effected by the lateral upright position of the patient, once recommended by Dr Willy Meyer.

DOCTOR LILIENTHAL said that when one drained a pelvic abscess through the abdominal incision he must be careful that the tube did not get among the coils of small intestine. It should be kept near the abdominal or pelvic wall, thus minimizing the danger of secondary obstruction.

Another point Doctor Lilienthal said he would like to bring out was that one could irrigate in a manner during the course of healing. He referred to the Carrel treatment of the abscess. He had found this of enormous value. It made for the comfort of the patient, for the cleanliness of the wound, and took away the odor. It would not, however, dissolve sloughs, which would have to be removed, when cast off, by other means.

In the matter of putting in the drainage tube, if it came out and one lost the track in putting it back by the probe method, Doctor Lilienthal said he had an exceedingly satisfactory method. It did not cause the slightest pain, was absolutely free from danger and assured one of getting the tube to the bottom of the cavity. He used an ordinary endoscopic tube. This was a rough, smooth, straight instrument which could be wormed into a tortuous tract straightening it out. It could be used to enter a recent sinus up into a subphrenic abscess or down into the pelvis. The patient would not feel the entrance of the instrument. When the endoscope was in place the drainage tube could be introduced through it and the endoscope removed.

DR ROBT T MORRIS emphasized the point that pus took the line of least resistance. We did not need a counter-incision. We owed it to the patient to give him the least attack of surgery possible in the course of appendicitis with abscess. This would belong to the fourth era in surgery, placing chief dependence upon the patient's own protective resources. After Doctor Clark published a report upon a hundred cases of pyosalpinx closed without drainage, Doctor Morris had closed the abdomen in a series of appendicitis cases without drainage and he found that nothing was lost. Nevertheless, he felt that it was best to drain through a small incision, using a flexible wick drain as small or as large as was necessary, depending upon the size of the patient and the actual mechanics of the situation.

As for the matter of flushing, Doctor Morris said he had never found flushing necessary so far as recovery was concerned, either at the time of operation or subsequently. It was objectionable at the time of operation. It might have a value in making the patient more comfortable as far as the question of odor was concerned as a post-operative bit of neatness.

DR WILLIAM A DOWNES described a drain which he had found very satisfactory. This consisted of a sheet of rubber dam about the size of a sheet of paper, folded loosely, and introduced to the base of the abscess. This drain was not removed, but was allowed to work itself out, this usually happened by the end of the eighth or tenth day. The wound healed well with this kind of a drain and the patient was usually discharged by the eighteenth day with only a small granulating wound remaining. Since using this drain, he seldom had occasion to worry about the formation of secondary abscess or fecal fistula. In acute appendicitis, where the appendix was deep in the pelvis, he had had it rupture through a McBurney incision, so unless he could feel the mass he made a straight mid-rectus incision, which was closed completely as a rule and a counter-incision made for drainage.

DOCTOR ELIOT remarked that the opinion seemed to be unanimous that there was no need of a rectal or vaginal counter-opening in the drainage of pelvic abscesses. He believed that while post-operative irrigation was not entirely free from risk, the danger of the invasion of the general peritoneal cavity by the irrigating fluid was practically nil if a sufficient time—say four

CONSERVATIVE TREATMENT IN SARCOMA OF THE LONG BONES

or five days—were allowed to elapse before irrigation was begun, and if a non-irritating fluid—such as a normal saline solution—were employed at a very low pressure.

Doctor Eliot said his experience with the use of Dakin's solution did not coincide with that of Doctor Lilienthal. From his own observation, as well as from that of the House Surgeon, the use of the Carrel-Dakin solution in no way shortened the period of wound repair. He did not think the solution restricted the formation or hastened the separation of aponeurotic or muscular sloughs, and to these, and not to the intraperitoneal structures, he believed the sloughy formation to be harmful.

Doctor Eliot did not wish to assert that the use of the catheter in the treatment of abscess cavity was superior to the use of the instrument described by Doctor Lilienthal. He did wish to emphasize, however, that by the use of this device, dressings were entirely free from discomfort, and the healing of the abscess cavity was rapid and uneventful.

Stated Meeting Held May 11, 1921

DR JOHN A. HARTWELL in the Chair

THE VALUE OF CONSERVATIVE TREATMENT IN SARCOMA OF THE LONG BONES

DR WILLIAM B. COLEY presented the following cases

CASE I—L. G., female, twenty-one years of age. *Central Sarcoma of the Lower End of the Femur*, with Extensive Involvement of the Knee-joint, mixed-giant- and spindle-celled sarcoma. (Full history with microphotograph published in the ANNALS OF SURGERY, March, 1917, p. 370.)

Amputation had been advised by every surgeon who saw the case, including Doctor Coley. Exploratory operation, toxins without other treatment for nearly one year. Complete recovery, two inches shortening. Well at present, with useful limb, six and a half years later.

CASE II (see ANNALS OF SURGERY, March, 1917, p. 370)—C. F., female, seventeen years of age. *Central Sarcoma of the Upper End of Tibia*, mixed-giant- and spindle-celled.

Admitted to the Memorial Hospital in August, 1915. Disease pronounced giant-celled sarcoma of epulis type, very moderate degree of malignancy, by Ewing, malignant by Barrie and Bloodgood. Curetting followed by toxins, three months later toxins discontinued on account of grippe, recurrence, second curetting, recurrence, again treated with toxins and one application of radium (pack) in addition. Complete recovery with useful limb, well at present, five and a half years later.

CASE III (see ANNALS OF SURGERY, December, 1919)—L. D., male. *Sarcoma of the Lower End of the Radius*, complete destruction of two to three inches of bone, impossible to say definitely whether periosteal or central origin from the X-ray and clinical signs.

May, 1918, admitted to the Hospital for Ruptured and Crippled. Tumor of rapid growth, amputation advised by several surgeons. Complete recovery under

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the systemic injections of the mixed toxins alone Well at present, three years later, with perfectly useful arm X-ray shows marked regeneration of bone

AN UNREPORTED CASE OF SARCOMA OF THE TIBIA

CASE IV—M C, twenty-three years, of Hartford, Conn

Family history negative Admitted to the Hospital for Ruptured and Crippled on December 5, 1920 Previous history negative up to July 4, 1920, when she fell on a hard floor, injuring her knee and bruising her ankle Two or three days after the accident she began to have pain in the upper end of the tibia, which gradually became worse She remained in bed for two weeks, at the end of which time she could not stand or walk without causing intense pain However, she kept about for four weeks, the pain gradually increasing in severity She then consulted Doctor Sweet, of Hartford, who made a diagnosis of tuberculosis of the knee and put her in a plaster case An X-ray picture was taken at this time The case was kept on for six weeks, when it was removed and another X-ray picture taken Three weeks later another X-ray picture was taken and a new case put on Pain became markedly worse, so much so that she was unable to sleep nights The patient lost some in weight and her general condition began to be affected On December 7, 1920, she was referred to Doctor Coley by Doctor Burlingame

At this time a careful examination of the X-ray pictures showed progressive destruction of the upper end of the tibia, with apparent involvement of the knee-joint Clinical examination showed marked enlargement of the upper end of the tibia extending down about four and a half inches, the swelling was most marked anteriorly, was soft, semi-fluctuating, and apparently involved the knee-joint

Diagnosis, based upon clinical symptoms and X-ray examinations Central sarcoma with complete destruction of the upper end of the tibia and involvement of the knee-joint

Treatment Curetting followed by injections of the mixed toxins of erysipelas and bacillus prodigiosus On December 7, 1920, under ether anæsthesia, a longitudinal incision was made, five inches in length, directly over the anterior portion of the upper end of the tibia and the knee-joint Cutting through the skin and subcutaneous tissue, a tumor about the size of an orange was found in the upper end of the tibia, which completely destroyed the cartilage of the knee but which did not involve the femur The old joint was disorganized and filled with fibrous, broken-down tissues, the tumor itself was largely cystic, containing five or six ounces of reddish-yellow fluid The cavity was curetted out Cavity extended down to the large vessels and great care was exercised not to injure them After protecting the vessels the rest of the cavity was swabbed out with pure carbolic and alcohol The cavity was then tightly packed with sterile gauze A pathologic fracture developed about three inches below the upper end of the tibia, which was completely destroyed Fibula was practically intact The limb was put up in a plaster spica, extending down to the foot, under extension

Three or four days after the operation the mixed-toxin treatment was begun, injections being made into the buttocks After removal of the cast, four or five days later, the cavity was kept sterile with Dakin's fluid The toxins were continued in increasing doses (beginning with one-half minim) up to the point of producing a severe reaction, temperature of 103° to 104° The cavity healed rapidly with normal granulations and at the end of a week the spica plaster cast was removed A shorter plaster splint extending to the upper portion of the thigh was put on and the wound dressed through a fenestra The patient made an uninterrupted recovery

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X-ray photograph, taken every two or three weeks, showed a gradual decrease in the size of the large cavity, and the more recent photographs show beginning regeneration of bone. The patient is not yet allowed to walk or bear any weight on the limb. A modified Thomas splint is being made by Doctor Gibney, which will enable her to walk about without bearing any weight on the foot. At the end of three or four months it is expected she will be able to walk again without injurious effect to the limb. Her general health showing improvement under the treatment.

Up to the present she has had thirty-nine injections of the mixed toxins, beginning with one-half minim and increasing up to ten minims. Highest reaction $=104^{\circ}$. Since last month she has been getting the toxins twice a week and later once a week, and it is my intention to continue the injections in small doses, not sufficient to produce a marked reaction, for a period of two or three months longer and then discontinue them altogether. The patient has had no other treatment than the toxins. It was intended to apply radium in case the disease was not quickly controlled by the toxins, but the progress of the patient was so rapid and satisfactory that it was decided to continue with the toxins alone.

Microscopic examination of the tumor removed (Doctor Jeffries) "Giant-celled sarcoma. The tissues exhibit a considerable degree of necrosis."

Microscopic examination (Barrie) "Definitely malignant tumor, fibro-sarcoma."

Microscopic examination (Doctor Ewing) "Giant-celled sarcoma, epulis type" (Fig 1)

Clinically it was markedly malignant, inasmuch as it had destroyed the whole upper end of the tibia and the knee-joint in the short period of a little over four months.

Giant-celled Sarcoma of the Right Radius (Hitherto Unreported)

CASE V—Mrs. M. F., forty years, family history negative. In June, 1919, she first noticed pain in the right wrist, shortly after which a swelling developed. There was no definite history of local trauma. Patient was obliged to give up work on July 1st, on account of the pain and swelling. Admitted to the Hospital for Ruptured and Crippled, Doctor Whitman's service, on November 29, 1919. An X-ray taken showed the lower end of the radius expanded by a tumor, cortex very thin, but the joint surface was apparently not perforated. Clinical diagnosis: Giant-celled sarcoma.

Operation December 1, 1919, by Doctor Kleinberg. The lower portion of the radius was found to have a very soft wall and to be movable, the point of mobility being about one inch above the styloid process. Below the point of mobility it was impossible to identify the periosteum. The central tumor occupying the whole lower end of the radius was carefully curetted. The tissue was for the most part gray in color with occasional areas of white tissue. The articular surface of the radius was not pierced. Only a small area of the posterior wall of the radius was intact. The cavity was swabbed with pure carbolic acid and washed out with alcohol, cavity packed with gauze.

Pathological report by Doctor Jeffries (pathologist of the Hospital for Ruptured and Crippled) "Giant-celled sarcoma." A section (Fig 2) was shown to Doctor Ewing, who pronounced it a giant-celled sarcoma of the epulis type. Dr. Geo. Barrie also examined the slides and pronounced it a hemorrhagic osteomyelitis. On December 13, 1919, the patient was transferred to Doctor Coley's service.

In view of the unanimous opinion of the three men, that it was a benign, giant-celled process and not a true malignant tumor, it was thought wise to make a test-case of it to determine whether or not it could be cured by simple curetting and carbolic acid, which, in the opinion of Doctor Bloodgood, is sufficient to cure practically all cases of benign, giant-celled sarcomas. The patient was discharged, and readmitted to the hospital on January 20, 1920. During the five weeks which had elapsed there was marked recurrence of the pain and the swelling had increased steadily. Examination showed marked enlargement at the site of the original lesion, there was false motion one and a half inches above the lower end of the radius, that is, pathologic fracture. Measurements over the lower end of the radius, eight and a quarter inches. Clinically, the tumor appeared to be malignant in spite of the pathological report. She was then put upon systemic injections of the mixed toxins of erysipelas and bacillus prodigiosus, beginning with one-half minim and increasing up to fourteen minims, producing reactions and temperature of 102-104°.

At the end of three or four weeks a decrease in the size of the tumor was noticed, which steadily continued until February 11, 1920, when the arm measured six and seven-eighths inches. In view of the fact that she had four children at home needing her care, she stated that she was unable to stay at the hospital and on February 21, 1920, she was discharged, apparently cured.

In the latter part of May, 1920, the lower end of the radius again began to increase in size, and slowly continued until July 1, 1920, when it had reached eight and one-quarter inches, the swelling apparently involving the radius for a distance of four and one-quarter inches (Fig 3,A). She was shown at a conference at the Memorial Hospital, and, it being the belief of Doctor Ewing that this type of tumor would yield to radium, she was accordingly admitted at once, and radium treatment begun.

From July 2 to October 20, 1920, she received a total of 69,250 millicurie hours of radium, a very large dosage. The photographs taken on July 2nd (Figs 4 and 5), compared with the ones taken on September 22nd, showed a very marked increase in the size of the tumor during the radium treatment, and X-ray pictures taken from time to time confirmed this increase in size. It seemed clear to Dr Wm S Stone and Doctor Coley that there was no hope of getting control of the disease by the further use of radium and it was believed that amputation was the only thing left to do. Before amputation, however, it was decided to make one more trial with the toxins. She was accordingly readmitted to the Hospital for Ruptured and Crippled, and as she was unable to be away from her home, she was treated in the Out-patient Department, where she received toxins three times a week. The injections were pushed to the point of producing fairly well-marked reactions, which she bore well, and which did not interfere with her household duties. The treatment was carried out most faithfully by my House Surgeon, Dr H H Shoulders, to whom belongs the credit for the results. All of the injections were made systemically in the buttocks. In less than two weeks the tumor began to decrease in size and the improvement has continued without interruption, until at the present time the tumor has almost entirely disappeared as far as X-ray and clinical evidence shows (Fig 6). The toxins were discontinued about two months ago, since which time she has had no treatment. No X-ray, radium, or other treatment than the toxins has been given since October, 1920.

The circumference of the wrist at the site of the tumor, which in October was nine and three-quarters inches, now measures seven and a half inches.

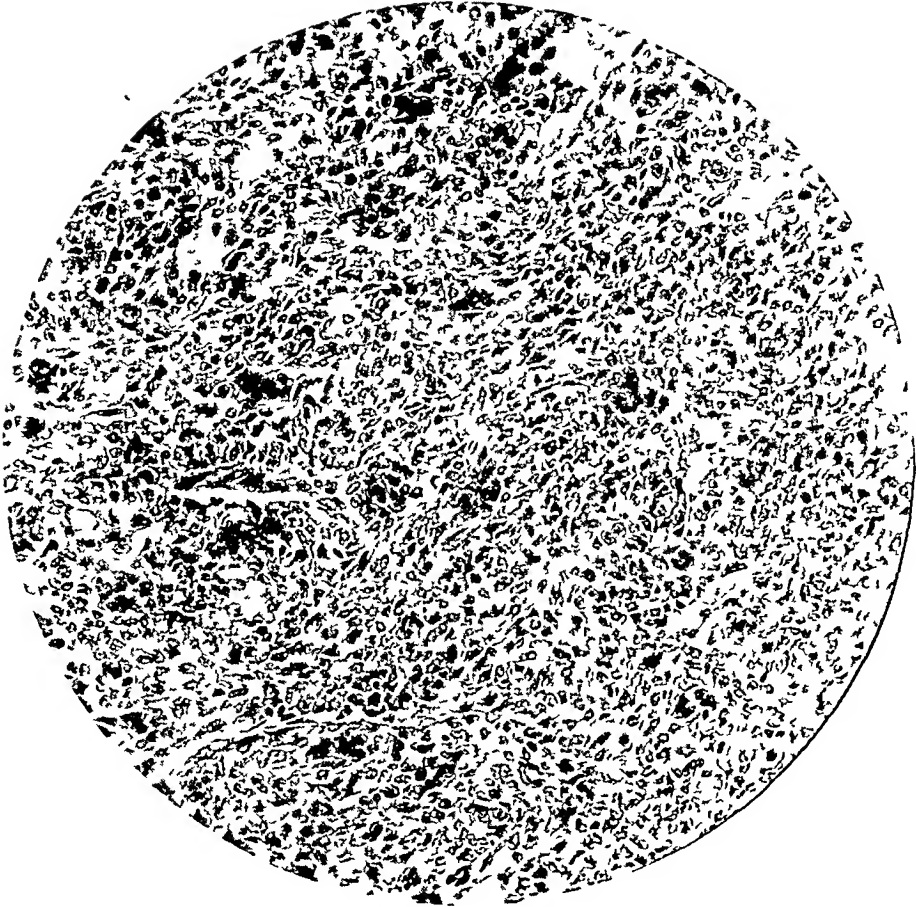


FIG 1 —Microphotograph of section of tissue removed from tibia of Case IV



FIG 2 —Microphotograph of section of tissue removed from growth in base of
radius in Case V M F



FIG 3 —Case V, M F A, condition July 22, 1920 B May 5 1921



FIG 4 —Case V, M F Condition September 22, 1920 after three and one-half months of radium treatment



FIG 5 —Case V M F Condition September 22 1920 after three and one half months of radium treatment

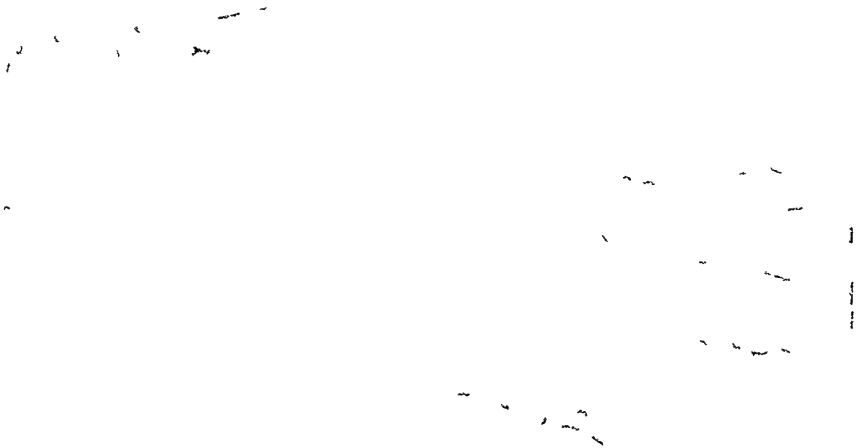


FIG 6 —Case V M F Condition eight months after resumption of toxins Tumor has nearly disappeared and function of hand is nearly restored

CONSERVATIVE TREATMENT IN SARCOMA OF THE LONG BONES

In view of the tendency of the disease to return it is intended to give her another course of toxin-treatment in the near future lasting for a period of two to three months

It would be unwise at present to say anything definite as to the final outcome
(Series of photographs illustrate this case)

DR. VIRGIL P. GIBNEY said he had seen a great many of Doctor Coley's cases, and had the opportunity of watching them from start to the finish, and usually seeing the end results. The most remarkable of Doctor Coley's cases was one he saw in the Montefiore Home some twenty or thirty years ago, in which a part of the spinal column was disorganized and the condition supposed to be an abscess from Pott's disease, but it proved to be malignant. The patient was a young man nineteen or twenty years of age. Doctor Coley apparently cured him and the man is well to-day. The majority of his results had gone on wonderfully well, so that Doctor Gibney felt when he saw a case of sarcoma that he wanted Doctor Coley to use radium and the toxins.

DR. JOHN A. HARTWELL stated that the important point was to classify these cases according to their malignancy. The whole subject of osteosarcoma was so confused as to the nature of the disease that until the pathologists and physicians together arrived at a classification it was very difficult to draw conclusions from a demonstration of patients who had remained cured in any form of osteosarcoma. The microscopical examination was so difficult in many cases that even several sections from the same patients studied by the same and by different pathologists failed to demonstrate what the disease was. As Doctor Coley had pointed out, there were very marked differences of opinion as to the so-called giant-celled type of sarcoma, some were very benign and some were quite malignant, some responded to mixed toxins and some responded to radium or to curettement, while others that had the same appearance as the ones cured by these methods did not respond to treatment and appeared to be exceedingly malignant.

As to the X-ray diagnosis of osteosarcoma, it was always very unsatisfactory. There were instances at a recent conference in which Doctor Bloodgood, Doctor Ewing and Doctor Codman were in doubt as to whether the condition should be classified as benign or malignant. Doctor Codman has formed a register of all cases of sarcoma that he could obtain. He asked that any surgeon who might have a case in which there was reasonable evidence, either X-ray, microscopical, or clinical, that the condition was sarcoma, be recorded with him. If one sent a card to Doctor Codman he would send the particulars as to how to register the case. He would also be glad in any case of suspected sarcoma to give aid in making the diagnosis and suggestions for treatment.

DOCTOR COLEY stated that he had radiographs of a patient who had a large tumor of the lower end of the radius which had completely broken through the bony shell, and he then presented them. He stated that the

history of the case had been reported in full in the *ANNALS OF SURGERY* (December, 1919) While it was impossible to tell from an examination of the X-ray picture the degree of malignancy of the tumor, it differed from the ordinary giant-celled central tumor in that it had completely destroyed the entire bony shell Clinically, it was malignant, as it was of comparatively short duration Doctor Coley said he was glad Doctor Hartwell had brought out the difficulty in making a diagnosis in sarcoma of the long bones He said that for more than thirty years he had been making a study of sarcoma of the long bones, clinically and microscopically, and later by the additional aid of the X-rays, and that there was yet much about the subject requiring further light Personally he believed we were much more likely to arrive at a correct conclusion by a careful study of a very large number of cases treated at a single institution in which the clinical and pathological studies were conducted by the same group of men He personally had observed about 300 cases of sarcoma of the long bones, and all of the specimens removed either by amputation or curetting had been carefully preserved at the laboratory of the Cornell University Medical School or at the Memorial Hospital These specimens and the microscopical sections from them are all carefully kept on file, making it possible to study them He believes that one could get more accurate data from a study of this large group of cases than would be possible from a larger number of cases collected indiscriminately from different observers, many of whom have seen but a single case or, at the most, but a very limited number The clinical and X-ray evidence was often of equal or even greater importance than the pathological examination The locality of the tumor in sarcoma of the long bones plays an important part, there are certain bones, *e g*, the humerus, in which it makes little difference whether the tumor be of periosteal or central origin, or whether the specimen histologically showed giant-cells or none at all Sarcomas of the femur and humerus are extremely malignant At a symposium on Sarcoma of the Long Bones, before the Royal Society of Medicine in London, November, 1912, it was brought out that not a single case of sarcoma of the humerus, at St Thomas' and St Bartholomew's Hospitals, had been saved by shoulder-joint amputation Butlin's very extensive statistics collected from the literature, showed almost no cases of sarcoma of the humerus remaining well for three years after amputation The same is largely true of sarcoma of the femur, nearly all cases being malignant, whether of myeloid or periosteal type

Doctor Coley has long held the opinion that, while one could state positively that practically all tumors of the periosteal type are malignant, it was not always possible from the microscopical examination to determine the degree of malignancy of central sarcomas of the long bones, that, while some of the central tumors with abundant giant-cells and a few spindle-cells, especially of the upper end of the tibia or lower end of the radius, could be classed as benign or nearly benign, there are other cases in which the histo-

SYPHILITIC OSTEOMYELITIS OF THE TIBIA

logical picture so closely resembles the former they can scarcely be differentiated, which recur after operation and kill the patient by metastases. Doctor Coley showed several lantern slides of microphotographs of giant-celled sarcomas in support of this view.

Doctor Coley stated that he, up to the present time, had succeeded in saving the leg or arm in eighteen cases of sarcoma of the long bones, twelve by the use of the mixed toxins of erysipelas and bacillus prodigiosus, and six by a combination of the toxins and radium or toxins and X-rays. He believes that the best results in the future will be obtained by combining the systemic effect of the toxins with the local effect of the radium. During the past seven years, at the Memorial Hospital, an attempt has been made to try out the different methods of treating sarcoma of the long bones. Doctor Coley added that the results of amputation are too well known to need further comment, that practically all of the periosteal cases proved fatal in spite of high amputation and only a small percentage of the central sarcomas, those of the myeloid type, have remained well beyond three years from amputation. Doctor Coley stated that a series of cases at the Memorial Hospital have been treated with toxins alone, another series by radium alone, another by toxins and radium combined, and a fourth by toxins following amputation. These results will be published in a series of 125 cases in full in a report which the Memorial Hospital will issue in the near future.

SYPHILITIC OSTEOMYELITIS OF THE FEMUR

DR F W BANCROFT presented a woman, who was admitted to the New York Hospital, December 16, 1920, on account of a swelling of the left knee of three months' duration. Three months ago while on an ocean steamer she fell on her knee, and upon rising could not walk without assistance. An hour later she began to have pain and the knee became swollen. The pain had persisted ever since. She had been treated for the three months before she came under his observation. When she came to the dispensary she had fluid in the knee-joint, no night spasm and no particular pain. She was feeling fairly well. The knee was aspirated and guinea-pig injected. The Wassermann reaction was positive, the blood count normal. X-ray pictures taken in the anteroposterior and lateral position showed the condition. While in the hospital the patient was given two doses of neosalvarsan and since that time anti-luetic treatment had been continued. The X-ray picture, taken April 18, 1921, showed the production of new bone and a diminution of the rarefaction shown in the first pictures. Besides the anti-luetic treatment she had received no treatment whatever. The fluid had not reaccumulated in the knee. There was normal motion and very little deformity.

In his description of syphilitic osteomyelitis McCallum says "Gummata formed in the marrow cavity are of sufficiently frequent occurrence, although they were practically overlooked until Chiari demonstrated their existence. They are gelatinous patches, often bright yellow from their content of fat, which may occur singly or in such numbers and continuity as to involve

the whole marrow cavity Generally there is no outward evidence of their existence, but the cortex may be attacked and eroded and the periosteum outside produce a new layer of bone to correspond In this way there may be a spindle-shaped dilatation of the bone, canals or fistulæ are formed through the cortex, and except for the absence of sequestra, the bone comes to look like the end result of an ordinary osteomyelitis"

Doctor Bancroft said the X-ray diagnosis was given as tuberculosis, but the patient had no elevation of temperature, no night spasm, and there was no pain, and the Wassermann was positive both by the cholesterin and alcohol methods Then the lesion was on the diaphyseal side of the epiphysis which was against its being tuberculous

OSTEOMYELITIS OF THE TIBIA

DR JOHN A HARTWELL presented a woman twenty-five years of age, who was admitted to Bellevue Hospital, December 23, 1919, with the history that when she was ten years old, she had an abscess over the internal aspect of the tibia, but could not relate the details in regard to it This had been healed many years, but she had recently had pain over the lower end of the fibula The X-ray showed osteomyelitis of the lower one-third of the tibia (Fig 1) The fibula was normal There was distinct tenderness with depression of bone at the site of the old abscess and slight thickening over the surface of the fibula

Operation on January 4, 1920, showed abscess in the bone two inches above the right internal malleolus, with sclerosis of the medullary canal (a Brodie abscess) There was no evidence of bone disease of the fibula The abscess cavity was curetted after removal of the cortex and the muscles allowed to drop into it Culture showed *Staphylococcus aureus* The cavity was dakinized The patient was discharged March 29, 1920, with the wound entirely healed and only slight œdema She was advised to use crutches and not to put any weight on the foot

On May 9, 1920, the patient returned, complaining of pain but no tenderness or redness in the lower end of the radius The X-ray showed a localized area of rarefaction, and a provisional diagnosis of bone abscess was made

August 23, 1920, she was readmitted for the wrist condition (Fig 2), which showed a tender swollen point at the end of the forearm over the radius

Operation on the following day showed a collection of pus about one-half inch from the articular surface of the radius The abscess cavity was curetted and packed with vaseline gauze A culture of the pus from the abscess cavity showed *Staphylococcus aureus*

On October 1, 1920, she was again operated upon for recurrence of the abscess at the site of the previous abscess of the tibia, two small pockets of infected granulation tissue were found These pockets were curetted into

one connecting cavity and all necrosed bone removed. The wound was left wide open and dakinized with the idea of doing a fat graft when the wound was sterilized.

Operation on October 22, 1920, showed the cavity lined with healthy granulation tissue, except one pin-head point at the lower end, where the granulations were slightly grayish. The bacteria count at the time on three successive days showed one in five fields. A fat graft from the upper part of the thigh, twice the size of the cavity, was compressed into the cavity and the skin edges sutured over it. Primary union resulted.

On November 23, 1920, examination showed that pain, tenderness and swelling had recurred. The X-ray showed a recurrence of the localized area of bone destruction at the outer half of the lower extremity of the radius (Fig 3). The leg wound was in good condition, the fat graft having apparently lived and filled the bone defect.

Operation, November 23, 1920, showed in the lower end of the radius a cavity left from the previous operation filled with pus and soft spongy granulations. The cavity was exposed by chiseling away part of the cortex. The cavity was curetted and dakinized with the idea of doing a future fat graft. Cultures of the pus showed the *Staphylococcus aureus*.

A fat graft was found unnecessary because the cavity in the radius completely healed, and the patient was discharged with normal motion in the wrist-joint on January 14, 1921. The left leg was entirely healed, but with slight œdema about the ankle.

On February 27th, the X-ray showed regeneration of the bone in the periosteum covering the implant and also a marked network of bony growth in the substance of the fat implant. There was also a sclerosing osteomyelitis and periosteitis of the lower end of the fibula, but no evidence of inflammation. These evidences of complete healing were still more marked in the X-ray taken May 7th.

The Bellevue Hospital pathologist's report on the specimen taken October 1, 1920,—curetings from the cancellous tissue of the tibia—is "chronic productive osteomyelitis."

The interest in the case centres about the regeneration of bone in the fat transplant as shown in the X-ray.

DOCTOR BANCROFT said there were three things quite clear which a bone graft must do: (1) It must bridge the defect and it must prevent deformity of the limb. (2) It must be of such a size and shape that the blood supply could be quickly established. (3) It must act as a stimulant for osteogenesis. With the Delageniere graft the part can be immobilized and the blood supply was easily established through the small bone fragments of the osteoperiosteal graft. As to the third point, there was a larger surface of raw bone with this kind of graft, and he believed that the large raw surface did more toward the stimulation of osteogenesis than any other factor. He believed that the failure of the medullary graft was due to the fact the blood supply

was cut off through the medullary nutrient artery, and for that reason failed. The inlay grafts did not interfere with the blood supply coming through the medullary canal and they exposed more surface of bone. He believed the Delageniere method was largely successful because a larger area of raw bone was exposed which stimulated osteogenesis, and there was no interference with the blood supply.

BONE GRAFTS FOR DEFECTS IN LOWER JAW

DR C A McWILLIAMS presented a man, now (Fig 7) twenty-four years of age, who was reported in the *ANNALS OF SURGERY*, vol lxxv, 1917, p 290, who had a defect in the lower jaw, the result of a discharge from a shot-gun. It illustrates the well-known fact that infection, and even sequestration, does not necessarily mean the non-success of the formation of new bone as a result of grafting. On June 7, 1916, the defect was laid bare, many buckshot were removed, the ends of the fragments were freshened, and two furrows were cut along the outer surfaces of the two fragments. Two drill holes were cut going into each furrow, an inlay graft from the tibia with its periosteum was laid into the furrows and fastened in place with kangaroo tendon. The skin over the graft was very thin and was evidently stretched too tight, for two weeks after the operation there was some necrosis of the skin edges, exposing the graft beneath. The opening never closed. For three months the upper and lower teeth were maintained immovable by wiring them. Three months after the operation a sequestrum, the whole length of the graft, was lifted out of the enlarged wound, which then soon healed, leaving an ugly depression in the side of the lower cheek. This was filled out with a pedicled flap from the forearm which was held to the side of the head by a plaster-of-Paris bandage for nine days, when the pedicle was severed. The skin graft healed in nicely, as you can see now. The bone graft proliferated finely, as you can now feel the solid bony ramus and see it by the X-ray. Mastication is perfect. In this case suppuration and sequestration did not seem to have any deleterious influence on the formation of new bone. As is seen in the radiograms, many buckshot have remained in the tissues for all these years without any deleterious ill-effects.

The second case was an Italian woman of forty-six years of age, previously reported in the *ANNALS OF SURGERY*, vol lxxv, 1917, p 289. The result of consolidation of the edges of a defect in the lower jaw, the result of osteomyelitis, was such a bad position that chewing was impossible. The site of consolidation was chiselled through, the fragments were separated, and a bone graft was inserted, end-to-end without inlay, and fastened in place with metal sutures. Because of infection the graft had to be entirely removed with the wires holding it. A second bone graft operation was performed on May 18, 1915. A graft, with periosteum from the tibia, was inserted end-to-end without inlaying with kangaroo tendon. The upper and lower teeth were wired together and this was maintained until October 1, 1915, four months. The wound healed kindly, the patient went home.



FIG 7—Ultimate result in restoring defect of the lower jaw
(McWilliams)



Fig. 8. Case I. Five years.

FIG 8 —Case I Five years after operation



FIG 9 —Condition of graft for defect in lower jaw six years after operation (McWilliams Case II)

BONE GRAFTING FOR SADDLE NOSE

Three weeks after the second grafting operation, she fell and broke the tibia, from which the graft had been taken. The crest of the tibia had been erroneously included in the graft. Splints were applied and healing of the fracture occurred as usual. It is now six years since the operation and you can feel both the sense of touch and of sight, and the radiogram, shows that there is a firm, lower ramus of the lower jaw at least an inch in its vertical diameter.

He said that in case he again had a bony defect of the lower jaw to graft, and this also is true of graftings anywhere, he would use the osteoperiosteal method of Delageniere, which has given the French surgeons such excellent results. He would fill in the space between the bone ends with bone chips from the tibia, and over the chips, on the two sides of the bared fragments, he would apply one or two strips of periosteum attached to which should be left plaques of bone, raised up from the tibia by a chisel. The successes with this method are greater than with the English end-to-end method, or even with the American inlay method. In addition, it is much the easiest and simplest method, doing away with complicated motor saws. This method should be more widely used in America, and, if an inlay graft were used, it could well be supplemented by an osteoperiosteal strip over the graft or placed on the opposite side of the fragments. Among 1390 graftings there were 82 per cent successful, and the proportion of successes was the same whether periosteum was on the grafts or not. There were 87 per cent of successes with the osteoperiosteal method, 82 per cent of successes with the end-to-end without inlaying, 80 per cent with the inlay method, and 76 per cent with the Murphy intramedullary procedure. In my opinion the intramedullary method should be discarded in favor of the osteoperiosteal method.

BONE GRAFTING FOR SADDLE NOSE

DR C A McWILLIAMS presented a man now thirty years of age, who was reported in the ANNALS OF SURGERY, vol lxxv, 1917, 789, having been operated upon, April 20, 1915. He had received a kick from a horse upon the bridge of the nose, fracturing and depressing its middle portion, producing a saddle nose. Two portions of a rib, with the periosteum on one side, were transplanted, one in front of the other, into a tunnel made down the front of the nose through a curvilinear incision across the root of the nose just where the cross-bar of spectacles would rest. There was primary union. The patient is presented now, after six years, to show that the primary, good, cosmetic result has remained as at first. The scar is not distinguishable. The rib grafts can be felt persisting as large as when transplanted, and they are so firmly attached to the frontal bone that they cannot be moved.

DOCTOR McWILLIAMS presented also a boy, now sixteen years of age, who had had a saddle nose, the result of inherited syphilis. He was operated upon one year ago. The reporter said that his first three graftings for saddle nose were made with bone from the ribs. Since then he had used

costal cartilage He has now performed five with costal cartilage, a method which offers many advantages over bone transplants in the nose (1) It can be easily moulded to any shape with the knife (2) If suppuration occurs, as may easily happen because of some unforeseen and undetected opening into the nasal cavities, cartilage resists infection much better than bone He had had three cases of costal grafts suppurate, and the cartilage remained *in situ* and lived after the infection had subsided, while in the third it sloughed out, after which the costal grafting was repeated with success

In this boy the costal rib graft was slipped in as in the previous case Slight suppuration occurred, but the effect on the cartilage was nil The graft has persisted and the cosmetic effect is all that could be desired

In reply to a question, Doctor McWilliams said that he would not advise bone grafting except as a last resort The greatest application was in non-union of fractures If one were going to operate simply for malposition, some other method would be better than bone grafting The only adequate method of treating non-union was by bone grafting The only other place where a bone graft should be used was where the defect was so great that the bone would not fill it normally The 17 or 18 per cent of failures indicated that we did not know much about osteogenesis, we did know the chemistry or the physiology of osteogenesis, we were in the dark about its rationale Doctor Neuhof had transplanted fascia lata into the bladder, stomach and ureteral walls, that was where the conditions were acid and had regularly gotten bone formed in the transplants This much Doctor McWilliams said was certain, bone was formed out of connective tissue Osteoblasts were indistinguishable from fibroblasts, then was deposited calcium which was the beginning of bone formation With all the methods of bone grafting, there were 18 per cent of failures It was one of the most disappointing things to have a bone graft heal in aseptically and then gradually melt away in the tissues He now had under observation a case of intramedullary graft which had healed without suppuration, but there was still non-union, because the graft had been absorbed

BOOK REVIEWS

SELECTED LECTURES AND ESSAYS. By SIR JOHN BLAND-SUTTON William Heinemann

This book opens with the story of the tendons and ligaments which was published many years ago by the author, showing the origin of many vestigial structures in man, and tracing them back among the lower animals. Most of those who studied anatomy twenty years ago will be familiar with these first few chapters. In them, the author shows not only that wide knowledge of anatomy which is associated with his name, but also a happiness of imagination in connection with certain speculative theories. He passes from ligaments to gizzards, from gizzards to calculi with equal facility. The chapter on "Post-mortem Digestion of the Stomach" is, in itself, of the greatest interest, reviewing, as it does, some of Hunter's original work.

In Chapter XVII he discusses ulcers of the duodenum and stomach, and here again his views are interesting and original, though many will be found to disagree with his conclusions as to the advisability of resection of the pylorus as a routine operation. He next passes to injuries of the heart, and gives in detail the first recorded case, described by Dr Guido Farina.

Missiles as emboli follow in the next. Then he turns his active and varied intellect towards the various sexual characters and malformations found in man and animals. Tubal abortion and tubal rupture have a chapter to themselves, while the history of the development of the antlers in bucks, and of circumcision, as a rite and as a surgical operation, are fascinating reading, this latter is accompanied by reproductions of reliefs from the Egyptian tombs, and numerous quotations from the Apocrypha.

Leaving surgery and anatomy for the moment, he enters the bull-ring, and gives us an admirable description of the work of the various performers and the reasons of their particular movements, each and all of which are destined to tire out the powerful muscles of the neck of the bull until he exposes the vulnerable point through which the matador can drive his sword. As this is an interspace with an average measurement of 4 cm, between the neck of the first rib and the transverse process of the vertebra with which the head of the rib articulates, some idea of the courage and dexterity and coolness demanded may be gathered.

Pulque and pulque-drinking next receives attention, while Chapters XXX to XXXIII are concerned with the medicine of the Bible, in which the author explains many of the curious occurrences therein recorded.

The last chapters conclude with the tale of a convoy. We understand that, in order to gain local knowledge and color, the author spent one of

BOOK REVIEWS

his hard-earned holidays during the war as a passenger on board one of the convoying vessels. It is admirably human and true.

Where all is so good, it is difficult to select any special portion for praise, certainly the book is one which everybody should read, as it is a true education to do so. A versatility that can range from ligaments to antlers, from antlers to Egyptians, from Egyptians to pulque, from pulque to the Bible, and from the Bible to the war, must excite our envy and admiration. The book is well written, excellently illustrated, full of happy quotations, and throughout there is an under-current of humor which is not its least valuable asset. Indeed, one can conclude this review in the words, quoted by the author himself in connection with Yorick, that "he is a fellow of infinite jest and most excellent fancy."

WM CLAYTON GREENE

LIFE AND TIMES OF AMBROISE PARE, with a new translation of his Apology, and an account of his Journeys in Divers Places. By FRANCIS R. PACKARD, M.D. Octavo, cloth, 297 pages. New York, Paul B. Hoeber, 1921.

The character and career of the man, the times and the part that Pare played in them will never cease to be of interest as long as the records of history endure and men continue to admire sterling integrity, unremitting devotion to duty and fearlessness of daily walk among countless snares and pitfalls, coupled with force, power, originality, foresight that render a man superior to the limitations that bind his fellows and make him the pioneer of a new era. For all this and more was Ambroise Pare. Pare was not only a great man and by nature endowed with the surgical genius, but he had both an instinct and an aptitude for writing that was a remarkable gift. A natural gift it was, for no training nor urge from others brought it into being. As a result no surgeon of his time is so well known, or has exercised such an abiding and beneficent influence on the healing art. There is no one in the annals of surgery that approaches him in all the elements of a well-balanced symmetrical character. In the book before us Doctor Packard gives an excellent digest of all that is known of Pare from his birth at Laval, to the day of his death in Paris, eighty years later, the favorite of princes, the confident of queens, the counsellor of kings and the friend of the helpless everywhere. It is difficult to add much if anything about Pare to the facts assembled by Malgaigne in his comprehensive introduction to his edition of *Oeuvres Completes*, published in 1840. Stephen Paget in his charming book on Pare and his times, by the Putnams, published in 1897, has given us in an English dress this whole story, but both these books are out of print. The present generation owes a debt of gratitude to the energy and interest of Doctor Packard and the public spirit of Mr. Hoeber that this new study of an ancient theme is made available to it.

LEWIS S. PILCHER

BOOK REVIEWS

DIATHERMY By ELKIN P CUMBERBATCH William Heinemann

This is a book which deals with a new method of treating disease. As the term implies, it is a "through heating," in which an electric current of a special kind, generated by a special machine, traverses the body. The tissues are supposed to be heated *throughout*.

The book opens with a historical note dealing with the work of Tesler and D'Arsonval, following a discussion of Nagelschmidt's method, who was really the first to introduce and popularize this method of treatment in this country. Various forms of the apparatus are described in detail, and careful illustrations are given, showing the method by which the sparks are obtained.

Chapter V deals with the physiological effects of diathermy, and it is pointed out that there is a very definite reaction on the part of the tissues to the current. Alterations in the blood-pressure are noticed, in one instance there was a fall of 10° in the systolic blood-pressure, while other charts illustrate the fact that there is a definite increase in the temperature. Generally speaking, as the result of the experiments described in Chapter VI, there is an elevation of temperature varying from 2° to 9° .

Chapter VII deals with medical diathermy, in which the therapeutic effects of heat are distributed generally, either to the body as a whole or to the part affected. Careful details are supplied as to the method of application of electrodes, and indications as to the strength of the current required for various conditions.

Sections III, IV and V of this chapter deal with some of the medical conditions for which diathermy has been used with considerable benefit, and they include circulatory disturbances, neuritis, sciatica, arteriosclerosis, paralysis agitans, gonorrhœal infections.

Chapter VIII considers the use of diathermy in surgery, and opens with an illustration indicating the amount of destruction which is caused when the active electrode is placed in contact with the tissues. In diathermy the electrode is cold when it is placed on or in the tissues, and remains cold until the current passes to it from the negative electrode. Anyone who has seen the cauterizing effect of this diathermy in surgical conditions must be astonished at the wide area of destruction created. Illustrations of the different forms of electrodes for use are figured, and details are given as to their methods of application.

In section IV the treatment of cases by diathermy is described, and the attention of the reader is directed to the danger of using this process of cauterization in the neighborhood of large arterial channels, which must always be ligatured as a preliminary, otherwise dangerous, even fatal, secondary hemorrhage may supervene.

In section V particulars of some cases treated are given, growths of the mouth and throat, of the palate, tonsil, inoperable carcinoma of the breast, rodent ulcer, warts, and papillomata of the bladder. It is in connec-

BOOK REVIEWS

tion with this latter affection that diathermy finds one of its greatest uses in surgery

The book is well printed, the illustrations are clear, there is an efficient index, and the author is modest in his claims on behalf of what is, at present, an experimental method of treatment. The method, however, will undoubtedly fill an important place in the therapeutics of both medicine and surgery

WM CLAYTON GREENE

MANUAL OF OPERATIVE SURGERY By JOHN FAIRBAIRN BINNIE Eighth edition, revised and enlarged, 1921, large octavo, 1311 pages, cloth Philadelphia, P Blakiston's Son and Co

The steady growth in importance and dignity of Doctor Binnie's book indicates not only the activity and industry of the author, but also the larger scope which the author has desired it to occupy and above all the even greater growth in the surgical activities of recent years

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LEWIS S PILCHER

INFECTIONS OF THE HAND By ALLAN KANAVEL Fourth edition, 8vo, 500 pages, cloth, 1921 Lea and Febiger, Philadelphia

This revised edition of Doctor Kanavel's studies upon infections of the hand will be welcome. The importance of the study will be recognized by all, for the crippling effects of hand infections are among the most common lamentable surgical sequelæ with which everyone is familiar. People do not often die as the result of infections of the hand and forearm, although they sometimes do. It is refreshing to turn from the surgery of the great cavities and viscera of the body to the common, ordinary, everyday subject of felons and abscesses. The author has approached his subject in a systematic way and has treated it with much thoroughness and skill. We commend this book even to experienced surgeons

LEWIS S PILCHER

FRACTURES By JOHN B ROBERTS and JAMES A KELLY 1921 Second edition J B Lippincott Company, Philadelphia and London

This edition is made up of 755 pages with 1081 drawings, radiograms and photographs

BOOK REVIEWS

This book supplies the reader with a clear, concise, and systematic presentation of the subject of fractures. It begins with a chapter on "General Considerations" and is closed with a treatise on "Industrial and War Fractures." Between these two chapters there is a complete and comprehensive description, accompanied by radiograms, or drawings, together with the accepted treatment of every type of fracture to which the bones of the human body may fall heir.

A few of the fundamental principles as set forth in this book seem worthy of presentation, however, at this time. Gentle handling is of the utmost importance. Radiograms of every case, and a general anæsthetic in most every case, are essentials. Early mobilization of fractures in or near joints is urged. It should be begun within the first twenty-four or forty-eight hours. The skin, the muscles and the neighboring joints must have not only early but constant attention. Some form of suspension, traction and counter-traction is the treatment of choice, especially in fractures of the femur and tibia. The majority of fractures of long bones do not require operative interference. Functional restoration is of more importance than anatomical contour. Open fractures usually require an operation so that a contaminated fracture may be converted into an aseptic fracture. This is best done within the first eight to ten hours after injury. If a closed fracture requires operation wait seven days after injury, if possible. Small fragments of bone in comminuted fractures should not be removed as they furnish centres of callus deposition. Ambulatory dressings are advised in every possible case. The Thomas splint is the apparatus par excellence to be used in the transportation of fractures of the arm or leg. However, the authors believe that all splints, appliances and apparatus available will in no way replace a thorough knowledge of the anatomy, pathology, and mechanics, without which the so-called "surgical grasp," which is so necessary in treating the individual fracture, is lost.

MERRILL N. FOOTE

A MANUAL OF SURGICAL ANATOMY. By CHARLES R. WHITTAKER, F.R.C.S. (Ed.) Third edition. New York, William Wood and Co. Edinburgh, E and S Livingstone. 1921.

The last or third edition of this book appears enlarged and revised and is found to contain many new illustrations. As its title implies, it is essentially a book for undergraduate work, but may, however, be profitably read and digested by the surgeon and internist.

The entire subject of surgical anatomy is thoroughly covered and is presented in a most interesting and instructive manner. To the student, as a supplement to his work in the dissecting room and to the use of his text-books on anatomy, and to the surgeon, as a means with which briefly to refresh his knowledge of the essential anatomy of the part to be operated, this book is highly recommended.

BOOK REVIEWS

AIDS TO OPERATIVE SURGERY By H C ORRIN, F R C S (Ed) William Wood and Company, 1921, New York

This small book of 236 pages has been written and published especially for the student preparing for his final examinations in surgery in the medical school It is in no sense to be regarded as a text-book on operative surgery It does, however, fulfill a real purpose, in that it gives to the student, in the most concise manner, the steps of the various surgical procedures The subject matter is systematically arranged At least one method of doing every conceivable operation is described Brevity combined with thoroughness seems to have been the author's aim It is an epitome, confined to the salient features and essential facts of the operations of surgery

MERRILL N FOOTE

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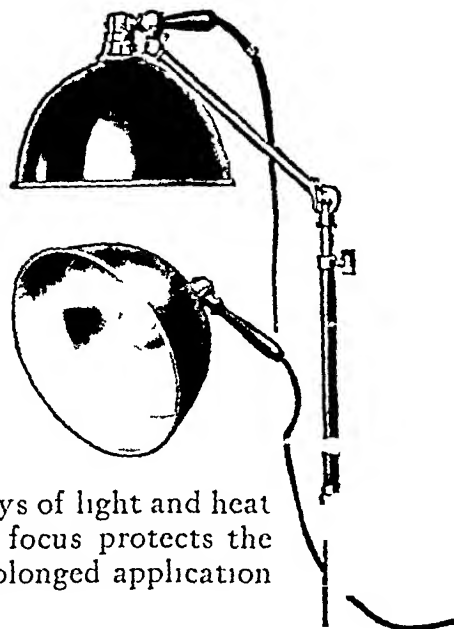
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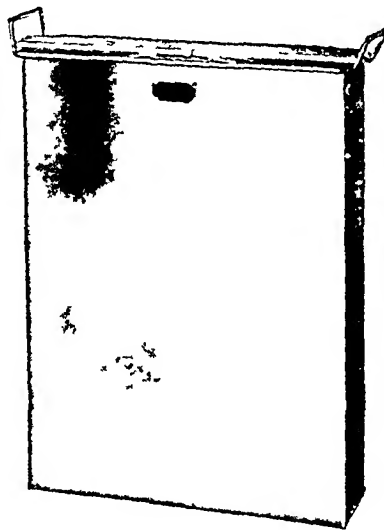
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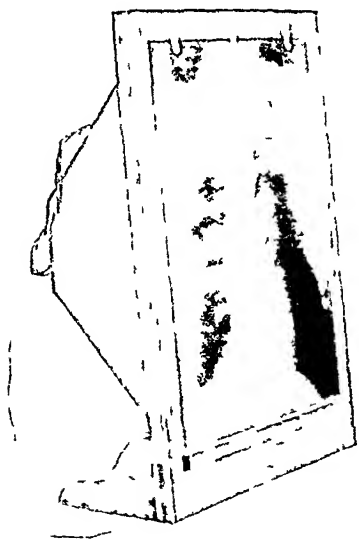
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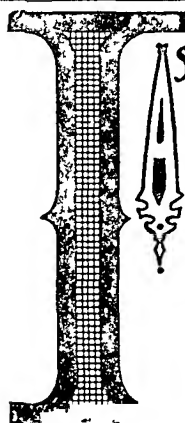
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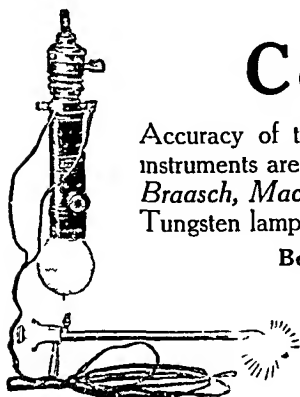
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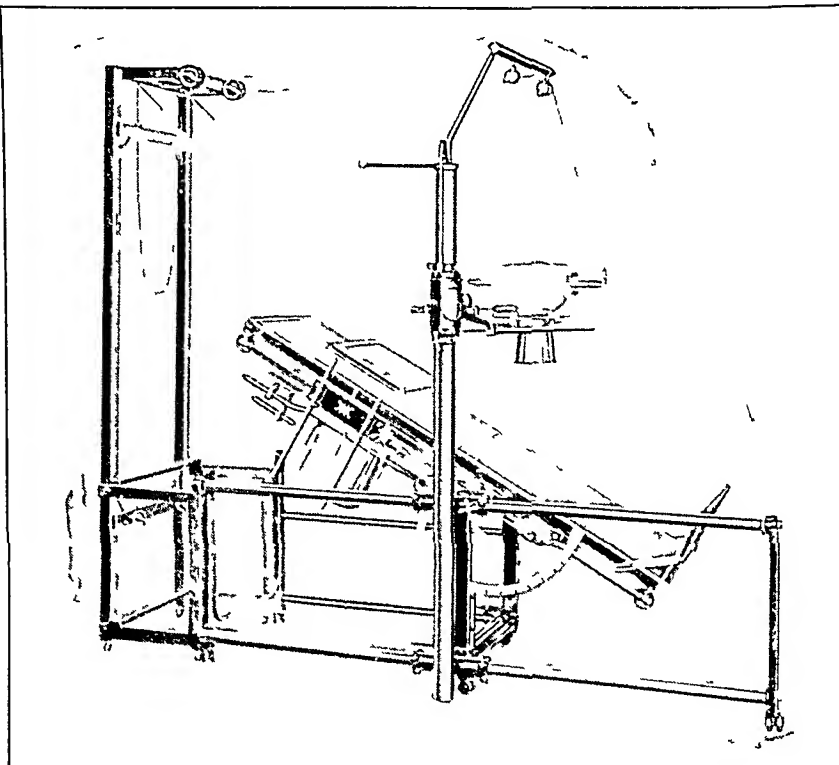
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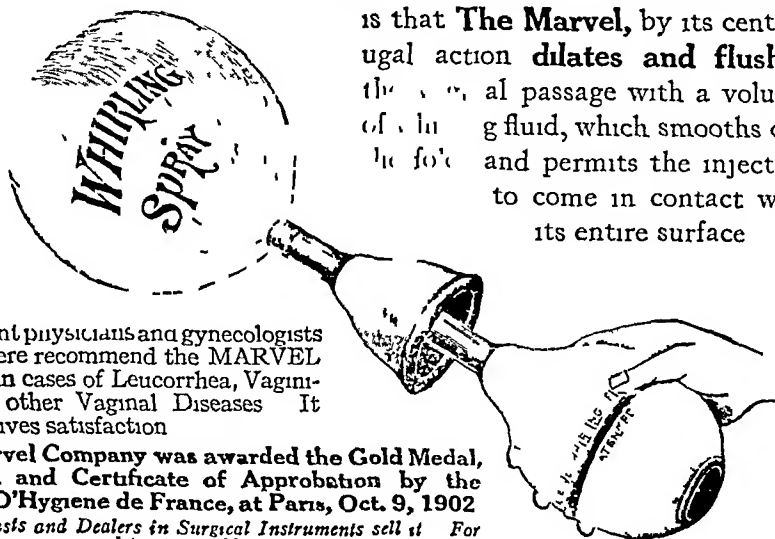


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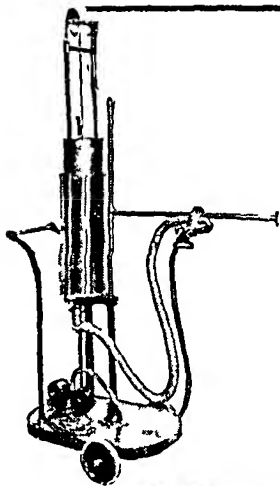
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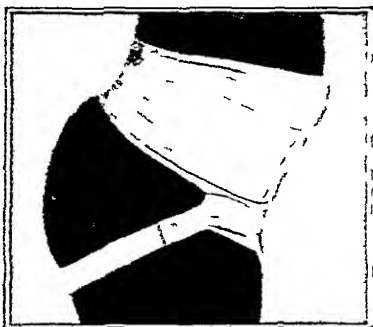
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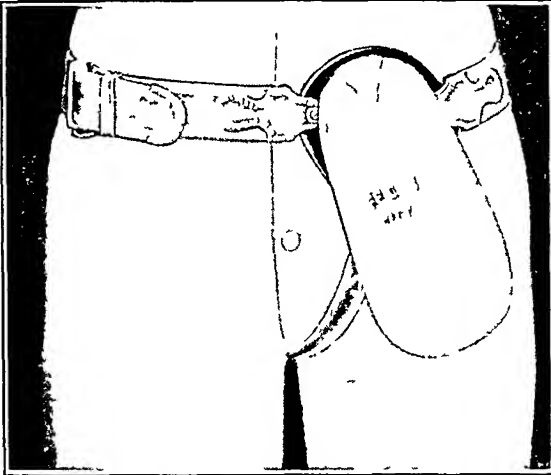


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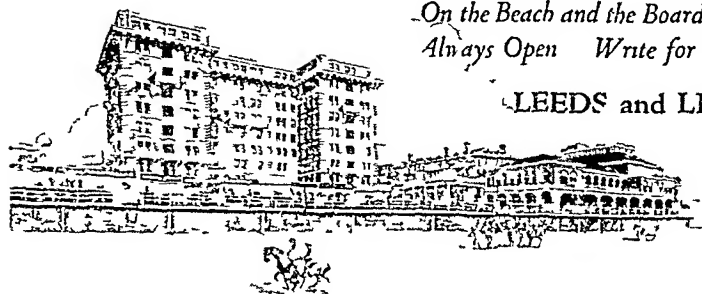
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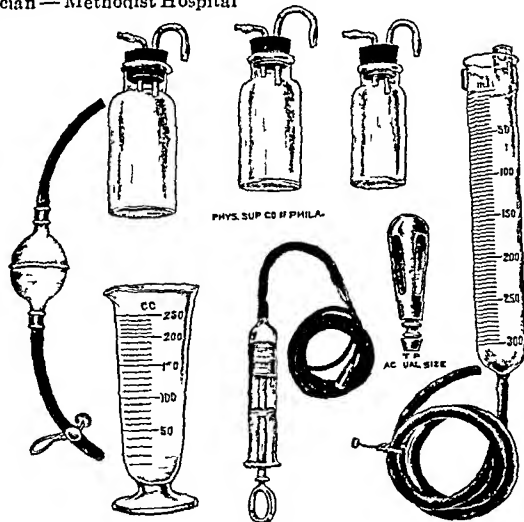
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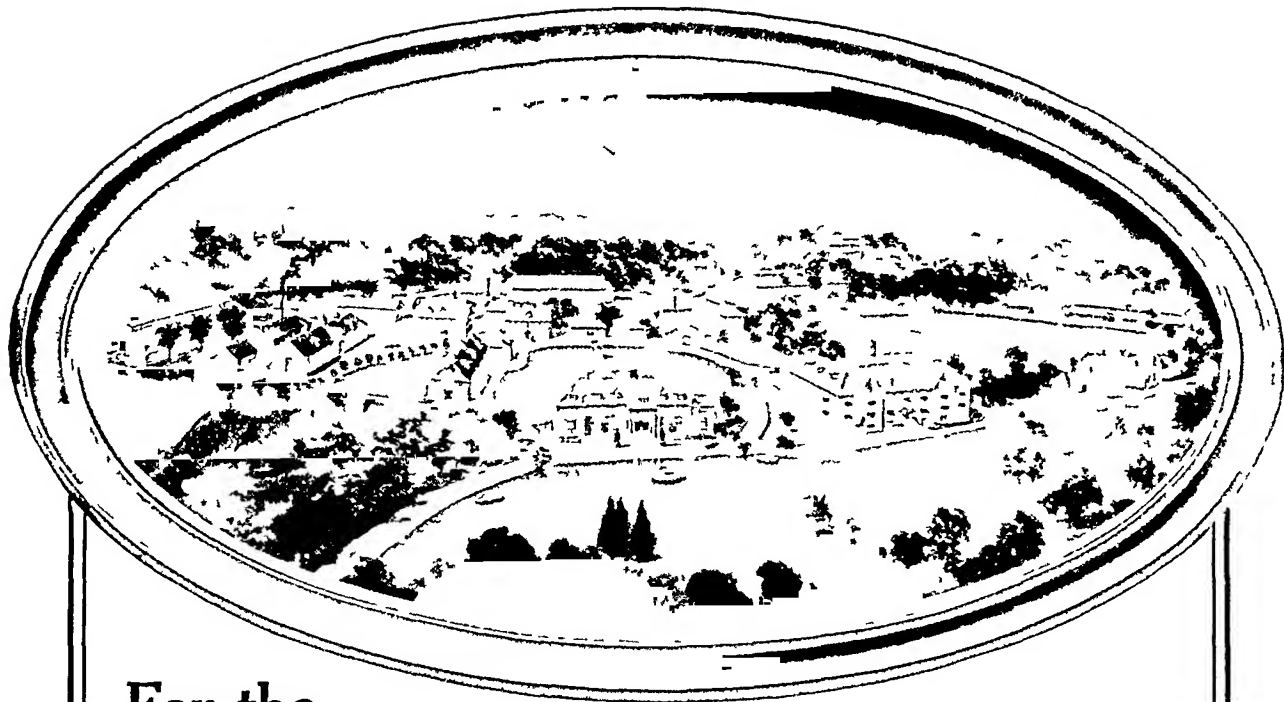
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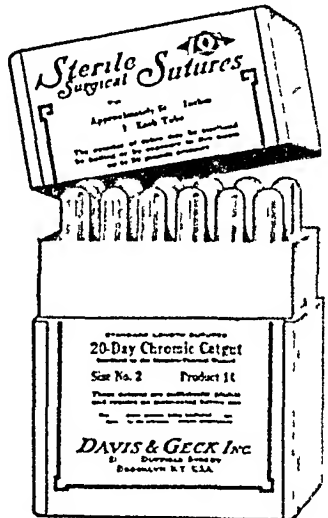
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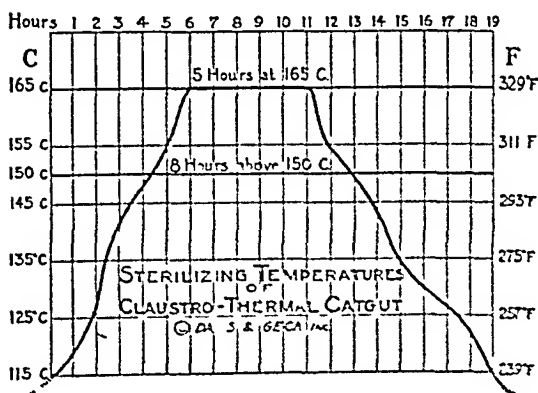
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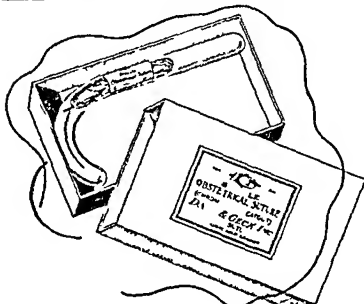
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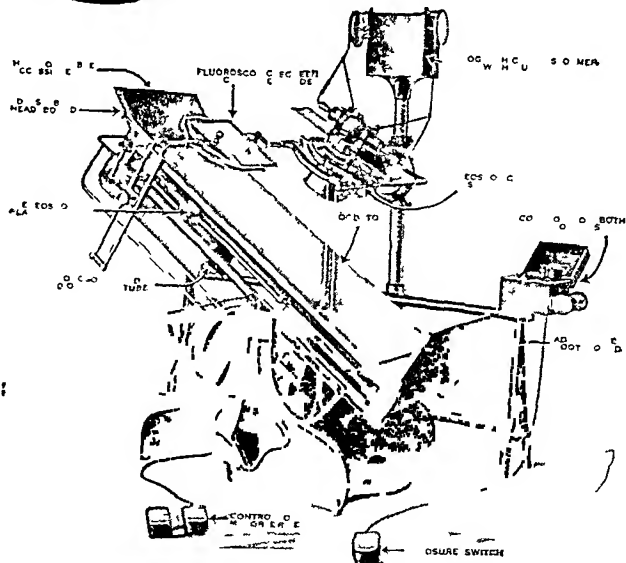
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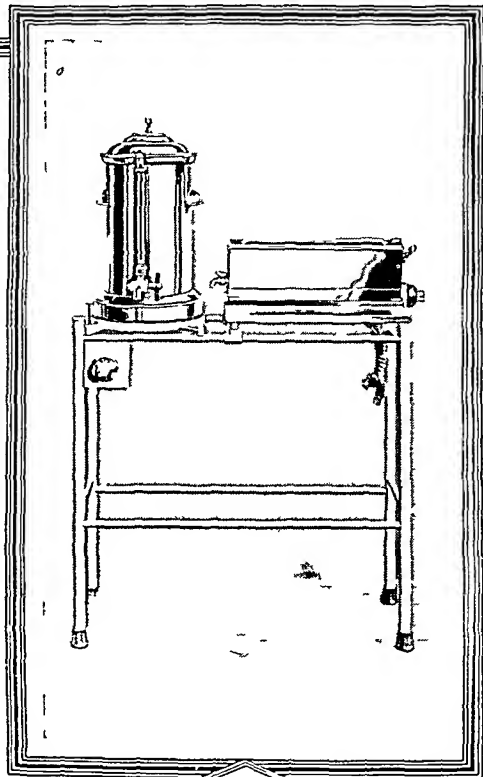
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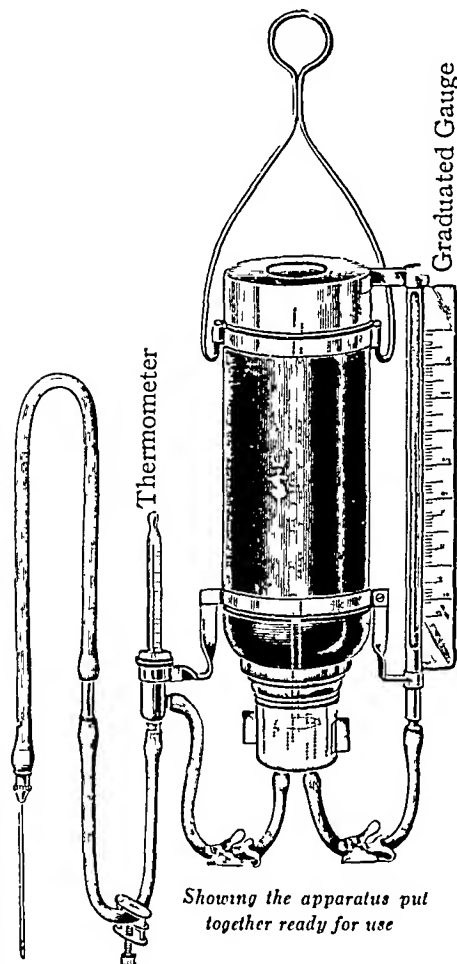
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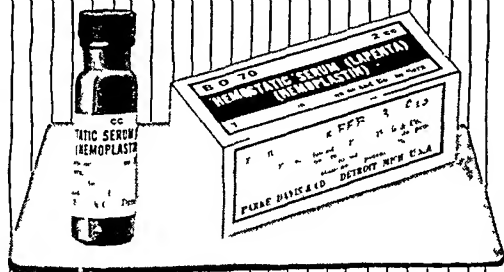
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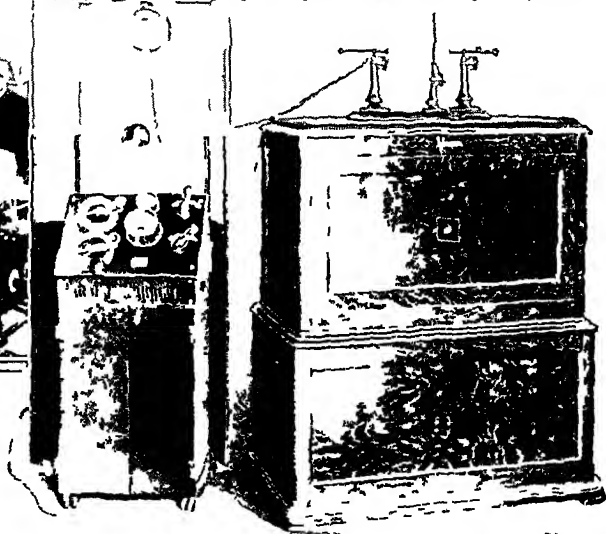


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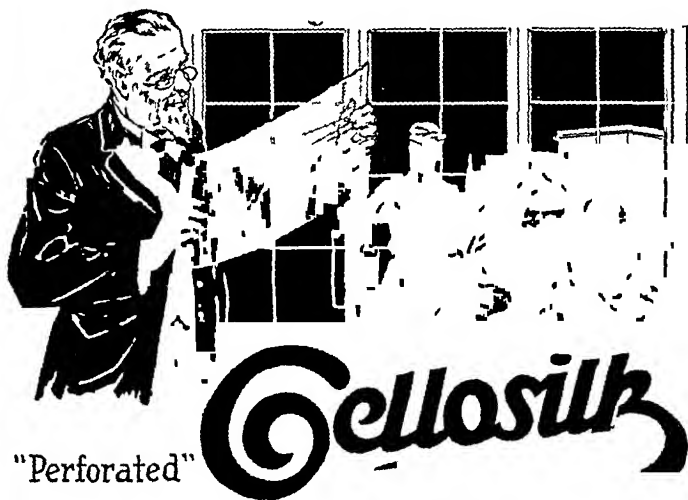
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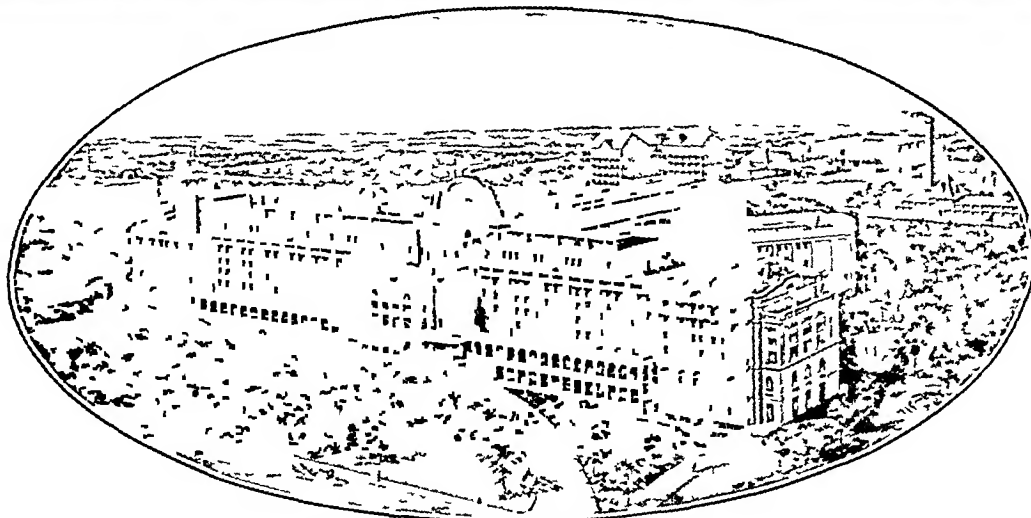
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ANNALS *of* SURGERY

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No 6

LATEST ACHIEVEMENTS OF THE ART OF LOCAL, REGIONAL AND SPINAL ANÆSTHESIA *

By GASTON L. LABAT, M.D.

OF ROCHESTER, MINN

SPECIAL LECTURER ON REGIONAL ANÆSTHESIA, THE MAYO FOUNDATION

IN unfolding the literature on local and regional anæsthesia, one is impressed by the slow but steady progress with which these methods have found their way into general surgery. Although they have not been universally adopted as a routine procedure, in many clinics on the Continent they have given a mortal blow to inhalation narcosis during the past few years.

Since the days of the innovation of local and regional anæsthesia by Reclus, Schleich, Selheim, Corning, and Bier, every effort has been strained to improve the results already obtained. Cocain, which was the only local anæsthetic of that time, fell almost completely into disuse when stovain and novocain came to light the same year. These drugs, particularly the latter, gave a new impetus to the methods on which cocain had already cast a heavy shadow.

After passing from the simple intradermal infiltration to the injection of the deeper structures along the line of incision, it could not be expected that local anæsthesia would give any better results than those already obtained by the pioneers, for the simply obvious reason that infiltration along the line of incision would always prove satisfactory when applied to interventions of the very minor types, or when the structures under the direct influence of the cutting instruments could be the site of repeated injections during almost the entire stage of the operative procedure. The "circular anæsthesia" of Hackenbruch was a real progress. It stands midway between local and regional anæsthesia, in that the anæsthetic fluid is distributed around the operative field.

It does not seem that local anæsthesia gradually developed into regional anæsthesia which is based on entirely different principles, but the constant desire for widening the scope of operations capable of being performed without the aid of general anæsthesia suggested the new procedures of nerve blocking by paravertebral and intraspinal injections.

The last decade was very prosperous in many an interesting feature of development. The important contributions of Braun, Lawen, Finsterer, Kappis, Kullenkamp, Hartel, Matas, Crile, Harris, Allen, Pauchet, Sourdat, and a host of others, have converted the method into an art and laid its funda-

* Read before the Chicago Medical Society, May 11, 1921

mentals on a scientific basis It is with the refinement of this art that we are chiefly concerned in this paper

Taking for granted that a thorough knowledge of nerve distribution is required of the surgeon who wishes to, I shall not say succeed in, but attempt nerve blocking, the technic itself exhibits such characteristic features pertaining to a specialty that he finds himself completely hopeless without a fair knowledge also of the principles of the method itself He has perhaps read hundreds of articles in which indications are set forth, advantages established, and cases reported He has perhaps watched many operations performed under regional or spinal anæsthesia and has left the operating room greatly impressed with the tremendous work that can be accomplished with a few injections of novocain Some inquire of the strength and the quantity of solution used, and so forth But, I am sorry to say, there are very few articles from which the ordinary physician is able to gather the true elements of the art of inducing a good regional or spinal anæsthesia Most of the literature conveys an impression of anxiety to arouse the enthusiasm of the reader by telling him how much can be done with the method and how safe it is, or, conversely, to discourage by pointing out its dangers and reporting after effects or fatalities Whatever be the subject under consideration, one should first study the principles of a method and all the circumstances attending its practice before making any attempt to use it The presence of some anæsthetic fluid in a human body is not always followed by anæsthesia, but its presence in the correct place will never fail to produce the desired result Let us, therefore, learn how and where to inject it If some patients are said to be "bad subjects for local," let us study the ways and means of bettering their condition by finding what is wrong with them and by trying to correct it If the injection is followed by pain or sloughing or produces toxic symptoms, let us see what is the matter with it, carefully observing the symptoms so that we may be able to attribute them either to the anæsthetic fluid or to the adrenalin added to it We must also beware of the coincidence of some other symptom due to a sudden attack of the disease Patients suffering from cholecystitis with stones have sometimes exhibited an attack shortly after the injection of morphin, but preceding the anæsthesia It might have happened during the anæsthetic procedure and might then have been interpreted by the inexperienced as a result of the anæsthetic drug Let us study briefly the chemistry, pharmacology and physiologic effects of the drugs we propose to inject and learn the ways and means of combating their occasional after effects In studying carefully the clinical aspect of our patients we shall learn how to distinguish between an after effect and a normal reaction and how to make a judicious use of the various procedures of regional and spinal anæsthesia without apprehension

I regret that I have not sufficient space to review the general principles of the method of which I have recently published a short review in the ANNALS OF SURGERY, but although restricting myself to only three topics of regional and spinal anæsthesia, I hope they will contain sufficient material to give

you a fair picture of the ploughing of that field in which some of us are now reaping wonderful crops

The dangers attending spinal injections of cocaine for surgical purposes led Cathelin, in 1901, to attempt epidural, caudal or sacral anæsthesia, which was placed on a practical footing by Lawen in 1910. Danis, in 1913, described a method of his own by which the sacral nerves could be reached through the posterior sacral foramina, forming lateral rows on each side of the sacral spinous crest. These procedures may be used separately or combined to constitute what I propose to call "sacral block."

1. When caudal injection alone is resorted to, 30 c.c. of a 2 per cent solution of novocain containing 10 drops of adrenalin (1:1000) should be used in preference to weaker solutions. The anæsthesia sets in less rapidly than in the other forms of nerve blocking, sometimes appearing only after from thirty to forty minutes and resulting only in analgesia which is insufficient for major operations, unless the patient has been strongly narcotized. It is, however, very satisfactory for hemorrhoidectomy, perineorrhaphy, provided the labia majora are not clamped too high, cystoscopy including fulguration, radium treatment of the carcinomatous prostate. For prostatectomy it is not always reliable. Lawen's bicarbonate novocain solution seems to hasten and intensify the anæsthesia and to increase its duration.

2. Transsacral or parasacral anæsthesia is obtained by introducing the needle from the rear through the posterior sacral foramina and injecting from 2 to 10 c.c. of a 1 per cent solution close to the nerves as they emerge from the sacral canal. The injection is best made with the patient lying on his stomach with a cushion placed under the hips. The anæsthesia appears very rapidly, almost instantaneously, and lasts for from two to three hours, very often there is no postoperative pain when sensibility returns. Its indications are all operations on the anus, perineum, vagina, prostate, bladder, urethra, and penis. When combined with caudal anæsthesia the result is an immediate complete block of all the sacral nerves, and it is considered the method of choice for the Kraske operation.

The foregoing description is but a rough sketch of the picture of caudal, transsacral or sacral block, and can only appeal to those who are already familiar with these procedures and have used them a number of times, but unless a clear detailed description throws more light on the technic we cannot expect the average physician to make them a part of his surgical equipment. Most surgeons have no time to read fifty odd pages selected from 11 chapters with the sole view of gathering the necessary data for one operation. They should be given every chance to acquire, in a few lines, the special technic which they are anxious to use. But they should also understand that unless they have satisfied the requirements of the method, no satisfactory results will be obtained. Nothing, however, can prevent the younger men in the early stages of their career from mastering the general principles of technic, in order to be able to appreciate the current literature on the subject and to use the method with complete success.

The following important points emphasize an adjustment of certain older principles to our modern technic. The preanæsthetic and postanæsthetic care of a patient, as well as the proper outfit for inducing regional and spinal anæsthesia, should have the special attention of the operator. The education of the patient as well as the control of his psychical condition, on which surgeons are still at variance, are the principal factors leading to success. In localities where the method is used extensively, home education is acquired very readily by friends and relatives who have already been operated on by the local method. But in countries where general anæsthesia has been the exclusive method employed, every patient is anxious to go to sleep as soon as an operation is proposed to him. Nurses should learn how to educate such patients as soon as they are sent to the hospital and should tell them all about the method so that they will know what is expected from them during the operation. It is too late to explain anything during the operation, it only helps to arouse suspicion and apprehension at a time when absolute quietude is desirable. The attendant at the patient's head should know how to use his or her judgment in seeking to divert the patient's attention to some other topic or to leave him alone if he feels sleepy and does not protest. The patient should never be told when the operation begins and such questions as "Do you feel that?", "Does that hurt?", "How are you feeling?", and so forth, are strictly forbidden, because they are suggestive and ruinous to the method. If it hurts he will say so. He only needs encouragement when he is anxious or when the length of the operation begins to be a burden or during a very short stage of painful manipulation.

I must emphasize the necessity for the use of narcotics preceding the anæsthesia, but I do not feel inclined to recommend the use of large doses such as would abolish consciousness or impair the general condition of the patient, whose resistance has already been lowered by the disease.

Under the subtitle "preliminary narcotism," Babcock, in 1914, advocated repeated injections of morphin and scopolamin before inducing spinal anæsthesia. A first hypodermic dose of one-sixth grain of morphin sulphate and one one-hundredth grain of scopolamin is given one hour and fifteen minutes before the operation, and a like dose is repeated in cases of robust adults, if in twenty minutes after the first injection they answer questions without evidence of mental confusion. A third dose, Babcock says, may be allowed in certain very robust and resistant patients, of either morphin alone or combined with one-fifteenth grain of apomorphin "if the delirifacient action of scopolamin predominates." These injections are given at intervals of twenty minutes and are used with great caution. I do not know if Babcock still precedes his spinal injections by such massive doses of morphin and scopolamin, but experience confirms the statement that although these combined drugs constitute the most valuable preliminary adjuvant to any form of anæsthesia, they may be reduced without compromising the results of local and regional, and even more of spinal anæsthesia, which is the block anæsthesia *par excellence*. In the majority of cases a single dose of one-sixth

grain of morphin and one three-hundredth grain of scopolamin, given an hour before the anæsthesia, controls the psychic condition of the patient satisfactorily. It is true that narcotics intensify and increase the duration of local, regional, and spinal anæsthesia. They facilitate the administration of general inhalation narcotics to such an extent that very nervous patients are able to take the anæsthetic easily, are maintained and controlled without any trouble with a relatively small quantity of anæsthetic, even during the longest and most traumatizing operations.

At the Clinical Congress for the Study of Local, Spinal and Scopolamin-Morphin Anæsthesia, held under the auspices of the Chicago Medical Society, January 26, 27 and 28, 1915, a most interesting discussion took place which ended in the common accord that scopolamin-morphin when used within the limits of safety so as to bring about a semi-waking condition, has always given gratifying results.

Experience proves that a weak dose of morphin, one-sixth grain, and scopolamin, one three-hundredth grain, used as a routine procedure is ordinarily sufficient to blunt the consciousness of the patient and eliminate to a satisfactory extent the factors of apprehension and discomfort and allow any operation to be performed painlessly, provided the anæsthesia has been induced correctly and every comfort ensured on the operating table. Exception should, however, be made when using the sacral block for the Kraske operation, during which the position of the patient on the operating table creates more discomfort than the operation itself. I am thus in the habit of administering to those patients my routine dose an hour before the anæsthesia and repeating the injection about fifteen minutes before the patient is brought into the operating room. With spinal anæsthesia it has not been found indispensable to use the preliminary narcotic, although the psychic condition of women is greatly benefited by the use of the weak dose. Experience has also shown that narcotics should always be given about one hour before the operation, if any good results are to be expected. The giving of a hypodermic injection of morphin immediately before the patient is sent to the operating room does not help the induction of anæsthesia, whatever the method used. It has been given too late and therefore acts more as an excitant than as a sedative.

Passing on to the anæsthetic drug, I wish to state emphatically that novocain is the anæsthetic of choice both for regional and spinal anæsthesia. It should be pure and freshly prepared. Novocain solutions, contrary to the opinion expressed by almost all writers, lose part of their anæsthetic properties by repeated boilings. Novocain hydrochlorid in powder can be sterilized by autoclaving, its melting point is 153° C. Fresh solutions, prepared by dissolving sterile novocain in cold sterile normal salt solution, are more active.

The addition of adrenalin (1:1000 solution) to novocain solutions is now a routine procedure and its action on the blood-pressure is not a novelty, but I wish to call the attention of the medical profession to its use in the future. I was using adrenalin in all my goitre cases (20 drops for each 100 c.c. of

the novocain solution irrespective of the strength of the solution), when I came across Goetsch's adrenalin sensitization test which led him to conclude that it is very near pathognomonic for goiter with exophthalmic symptoms. Contradictory findings have been published, but my clinical experience tends to show that we should be a little more cautious in using the drug. I have reduced the dose to 15 drops for each 100 c.c. and do not inject more than 20 drops in the average cases, when more than 100 c.c. of the solution are required. In many instances the poor condition of the heart or the high blood-pressure prompts the use of a still weaker dose. For thyroidectomy I still use 10 drops for each 100 c.c. of the 1 per cent solution in paravertebral injections, injecting about 50 c.c., that is, 5 drops of adrenalin in all, but if the patient's condition has been diagnosed exophthalmic goitre, I take the safe side and inject pure novocain.

I confess, however, that I had, before taking cognizance of Goetsch's experiments, used adrenalin in all my solutions irrespective of the nature of the disease.

I am thus led to a "*mise au point*" of the alleged danger of blocking the phrenic nerve and the vagus when making paravertebral injections of the cervical nerves. Wieman found that for thyroidectomies, when regional anæsthesia is induced the day before the operation with a view of determining the exact mechanism of the occasional after effects resulting from paravertebral injections, X-rays in a certain number of cases reveal paresis of the diaphragm on the same side, but without any subjective disturbances. The pulse is sometimes slowed, sometimes accelerated, and sometimes unaffected. The most interesting feature of this experiment is the absence of any trouble at the operation the next day, although the anæsthetic is applied on both sides with three or four times as much solution. If the injections are carried down close to the transverse processes laterally, there is very little risk, if any, of blocking the vagus, but it seems to me that the phrenic nerve is anæsthetized in every case although not to such an extent as to paralyze the diaphragm, even then, the intercostal and other respiratory muscles compensate for the functional deficiency of the diaphragm.

During the years 1919 and 1920, some very interesting work has been done on the anæsthesia of the abdominal cavity and its content. The difficulty encountered in handling painlessly the diseased viscus after laparotomy under local anæsthesia of the abdominal wall had already given rise to the paravertebral conduction method in order to obtain a wider anæsthetic field on which the surgical manœuvres would not create too much discomfort to the patient. It was necessary to inject from the fifth dorsal to the second or third lumbar nerves on both sides, that is, twenty to twenty-two nerves (Kappis), or from the seventh to the twelfth dorsal nerves (Labat), that is, twelve nerves. In the latter case, the diffusion of the solution to the adjacent upper and lower nerves probably accounts for the success notwithstanding the difference between the two procedures. Finding this method tedious to the opera-

tor and trying to the patient, a certain number of experiments were conducted with a view to finding a simpler method

In 1913, Kappis made extensive experiments on dogs with a view to throwing some light on the existing conflict of opinion regarding the sensory distribution of the abdominal cavity and its content. Excluding the use of narcotics he tried to determine what pain it would be possible to induce by irritating the intestines. He divided his experiments into two parts, first, a preliminary, and second, an examining operation. Sections of the cord were made at different heights, sections of the abdominal wall along the costal margin, and the results of his experiments were the following. After sectioning the cord between the fifth dorsal vertebra and the sixth dorsal vertebra there was no pain in the abdomen. After sectioning the cord between the seventh dorsal and eighth dorsal vertebræ, there was no pain in the lower abdomen up to the middle of the small intestine, but the stomach, spleen and upper part of the small intestine were found sensitive. Between the thirteenth dorsal and the first lumbar vertebræ (the dog has thirteen dorsal vertebræ), sensibility stopped at the cæcum. Kappis concluded, therefore, that below the cæcum all organs are supplied by lumbar and sacral nerves. This is confirmed by my clinical experience that the blocking of the three last lumbar nerves and the five sacral nerves gives a complete anæsthesia of the pelvis and its contents.

The sectioning of the splanchnic nerves done by Kappis gives an anæsthesia of the stomach, spleen and upper part of the small intestine. The liver seems to bear an embryologic relationship to the gastro-intestinal tract. The kidney was not deprived of sensibility after sectioning the splanchnics, which proved that at least part of its sensibility originates from the lumbar spine. In 1919, Kappis published another very interesting contribution, which adds to the knowledge obtained from his papers of 1913, that the three first lumbar nerves send rami-communicantes to the retroperitoneal ganglion and therefore take part in the transmission of pain from the upper abdominal organs below the sigmoid colon, whose sensory innervation ends with the third lumbar nerve. The sensory innervation goes through the hypogastric plexus to the rectum and to the urogenital apparatus.

Hoffman's clinical findings, published in 1920 confirm to a certain extent Kappis' experiments, proving that sectioning of the spinal nerves supplying the abdominal wall is not followed by an exclusion of painful impulses which are always present in the mesentery. He also found that the sectioning of the splanchnic nerves abolishes pain, and is of the opinion that these findings can be applied to man. Hoffman goes still further in contending that there is no difference in pain sensation between the cerebrospinal and vegetative nerve systems, which is contrary to the opinion of Lennander, who holds that no sympathetic fibres are able to transmit pain. Hoffman says that both systems have the same centripetal tracts, that they transfer the same conscious sensibility and that they have a unit embryologic history, that the sensory nerves lie in the parietal peritoneum, mesentery, and lesser omentum, and that

these organs are the starting point of abdominal pain. He made sections of the peritoneum and used the method of Bielschowski modified by Schultz and Gross, in which nerves are tinted black and easily seen. Vessels are sometimes stained by this procedure, but good pictures of nerve ramifications are usually obtained by which it is easy to distinguish the nerves from the blood-vessels. Sensory nerve fibres were found to accompany the vessels of the mesentery and also those of the parietal and visceral peritoneum. Certain regions between two vessels contained no nerves. Clamping two adjacent vessels of the mesentery produced pain, and in treating this region by the above process it was found that the clamped vessels contained nerves coming from the splanchnic or sympathetic chain. Dissections also showed that the splanchnic nerves had fibres running to these clamps.

Kappis does not deny the presence of nerve plexuses supplying the viscera and containing sensory nerve fibres, especially pain-conducting fibres. Their number is relatively small as compared to the extent of the viscera supplied and for this reason they lose their ability to transmit painful impulses in the proximate vicinity of the organ itself. It may be that these fibres do not reach the organ with the other nerves but end at a certain distance from it, it may also be that they do not reach the organ in such number and size as to permit of impulses being interpreted as pain. Clinically, abdominal organs are insensitive.

Consequent upon the above findings it was thought rational to try the anæsthesia of the splanchnic nerves and that of the rami-communicantes given off by the first three lumbar nerves. A posterior route of approach was studied on the cadaver and applied to the patient, which has given, in the hands of Kappis, Naegeli, Hoffman, and myself, satisfactory results, especially in very lean patients. The solution diffuses sufficiently in the retro-peritoneal tissue to secure at the same time the anæsthesia of the cerebrospinal nerve plexuses lining the posterior wall of the abdominal cavity under the direct influence of the operative manœuvres. The technic is simple and safe and should be tried as often as possible in abdominal surgery.

I should like to approach the question of spinal anæsthesia, not with the view of discussing the methods already employed on the Continent and in America, but of presenting a technic I have been using for the last three years without any untoward effects, and I may say no failures. The practice of dissolving the anæsthetic drug in cerebrospinal fluid for the purpose of intraspinal injection is not new, but the many little details attending the injection of such a solution are those to which I wish to call your attention, since my impression is that the absence of one or more of them is likely to bring about troubles ranging from the simple headache to the occasional cessation of respiration. Briefly, my technic is as follows.

The patient is injected in the upright position as usual. The puncture is made at any level between the twelfth dorsal and the fifth lumbar vertebræ, according to the height of the anæsthesia desired. No attempt is made to produce anæsthesia higher than the line of the nipples. After making the

puncture, the first few drops of cerebrospinal fluid are allowed to flow out, so as to obtain a clear fluid which is allowed to fall in a special ampule containing the anæsthetic drug. More fluid is withdrawn, varying between 10 c c and 25 c c, according to the condition of the intraspinal pressure which very often agrees with the blood-pressure. The appearance of headache should prompt the cessation of further withdrawal of fluid. The solution thus made is aspirated into any kind of syringe by means of a spare needle, the syringe is then adapted to the spinal puncture needle and as much new fluid is brought into the syringe as it now contains solution. Half of this is injected very slowly, more new fluid is aspirated, the syringe is discharged in the same way, leaving less and less fluid in it, and at the end of four or five injections it is emptied. There is no hurry in placing the patient in the recumbent position, but there is also no reason for keeping him in the erect position. He is, therefore, placed on his back, and, by the time the operative field is prepared, he can be placed in the Trendelenburg position and stay there until sensibility returns without prejudice to his respiratory function. As is usual with spinal anæsthesia the blood-pressure falls in the majority of cases very rapidly, affecting only the maxima, and comes back to normal later, sometimes during the operation and sometimes only in the afternoon, without changing the clinical aspect of the patient whose condition he, himself, considers to be very satisfactory. The minima is but little affected. No postanæsthetic headache, nausea or vomiting has been observed following 110 * spinal anæsthesia given in the Mayo Clinic since my arrival October 2, 1920. A nauseated condition sometimes exists, especially with the Trendelenburg position, which disappears rapidly by deep breathing. No special postanæsthetic care nor position was especially indicated in the patients thus anæsthetized.

I am familiar with Barker's and Babcock's solutions and technic. After using stovain, cocain and a combination of cocain and novocain, in varying doses, I have adopted novocain in doses of 0.10 gm and 0.12 gm, according to the body weight of the patient. One centigram for each fifteen pounds of body weight has clinically proved to be a safe dose and produces satisfactory anæsthesia for a period varying from one hour to one hour and a half. No adrenalin is added to the novocain which should be chemically pure and sterile. Adrenalin is here of no use, since its action on the blood-vessels is of no avail in the spine.

The necessity for making the injection as slowly as possible is to keep the solution in the close vicinity of the site of puncture and allow the nerve structures to take up the greater part of the anæsthetic, leaving a dose too weak to produce anæsthesia by diffusion higher up. The anæsthetic fluid acting as a dye impregnates the nerve tissues more deeply at its first point of contact.

After withdrawing a certain quantity of cerebrospinal fluid the intraspinal pressure decreases while the secretion and excretion of more fluid has to take

* The number has since greatly increased

place in order to make up for the deficiency created by the withdrawal of such fluid, so that if the intraspinal injection is made very slowly there is no reason why the injected solution should ascend toward the head. The normal circulation of cerebrospinal fluid also helps the injected solution to flow toward the blood circulation, that is, toward the periphery. I do not consider the cessation of respiration which might happen in such cases to be due to the direct action of the anæsthetic fluid on the respiratory centres by diffusion up the spinal canal, but its passage in the general circulation is probably the cause of such trouble when too heavy a dose has been administered. Without exerting great pressure while making the injection, the anæsthetic fluid does not ascend toward the head when using cerebrospinal fluid as the solvent of the novocain. Patients placed in the Trendelenburg position for one hour do not show anæsthesia of the upper extremities, thus indicating that no solution, at least no active solution, reached the emergence of the roots constituting the brachial plexus. The spine cannot be considered as a test tube and all experiments *in vitro* cannot be applied to the human spine unless rough handling of the technic disturbs the physiology of its contents. The disturbance of the contents of the subarachnoid space may be compared to that of a vessel containing water, whether still or circulating, when a stone is thrown into it (the injection representing the stone), ripples will be formed which represent the injection waves, the heavier the stone, the greater the disturbance and the larger the ripples, the greater the pressure with which the injection is made, the greater also is the intraspinal disturbance and likewise the injection waves, which then might reach the head.

Le Filliâtre was the first to induce general anæsthesia by means of spinal injections made as low as between the fifth lumbar vertebra and the sacrum. His technic is based on the fact that great pressure is capable of running the solution up toward the head, thus producing general anæsthesia.

The conclusion must be reached that pure sterile novocain, dissolved in cerebrospinal fluid in doses of 0.01 gm. for each fifteen pounds of body weight of the patient, is a safe procedure, provided the injection is made very slowly.

I have not seen any contra-indication to spinal anæsthesia with the technic I use, unless it is in patients whose blood-pressure is below 100. Even then, if the condition of the patient does not allow him to have any other form of anæsthesia, I would not hesitate to use spinal anæsthesia, injecting, at the same time subcutaneously, spartein sulphate, one grain, caffein, four grains, and strychnin sulphate, one-sixtieth grain, repeating the dose, if necessary. Patients suffering from fibrillation of the auricles have behaved themselves very well under spinal anæsthesia when operated on for diseased gall-bladder or prostate.

CONCLUSIONS

Regional anæsthesia, in which should be included spinal anæsthesia, has developed into a science and should be treated as such. To be successful the anæsthetist should have a perfect knowledge of anatomy and surgical technic,

and should be familiar with the chemistry, pharmacology and the physiologic effects of the drugs he administers. He should know how to handle the patient before and during the operation and, above all, have mastered the general principles of the methods.

The surgeon who operates under regional anæsthesia should be familiar with the general principles of the method so as to be able to complete the anæsthesia during the operation. He should not have recourse to general anæsthesia when one or two injections, judiciously made, would render the operation painless. Such knowledge would also give him a correct idea of the extent of the anæsthetic field and in a general way help him to understand the after-effects, if any, and the treatment thereof.

The beginner should not be expected to be successful with his first attempts, partial failures can be remedied by inhalation narcotics. He should not abandon the method as being worthless or insufficient. He should remember that even experts may fail and should try it again, observing scrupulously its principles until he succeeds. There is no reason why he should not succeed when in the hands of others the results have been so satisfactory. But he can readily understand from the foregoing how necessary it is to have an exact knowledge of the technic and attending circumstances of spinal anæsthesia if he wishes successfully to employ such a delicate procedure.

Novocain is the anæsthetic drug of choice in both regional and spinal anæsthetic procedures. It should be pure, and when injected intraspinally, pure and sterile and dissolved in the cerebrospinal fluid of the patient. The dose of 0.01 gm of novocain for each fifteen pounds of the body weight of the patient, injected very slowly, is safe for any operation below the diaphragm.

May I at the end of this paper suggest that every young medical student should devote part of his time to studying this method so as to be able to apply it later on in his own private practice? And since a knowledge of general surgery is required, he who is anxious to make it a specialty should have a post-graduate course in that subject.

THE MALIGNANT DEGENERATION OF BENIGN TUMORS OF THE THYROID GLAND*

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It is admitted generally that cancer of the thyroid gland, as cancer elsewhere, has a tendency to develop in those glands which have been the seat of preexisting disease, *i e*, goitre. In order to determine the relative degree of malignant degeneration found in the various benign lesions of the thyroid, we have examined the material obtained in the Surgical Laboratory with this idea in view, attention being directed to the association of cancer with colloid goiter, colloid and foetal adenomata, and papillary cystadenoma.

Although cancer of the thyroid has been regarded as a rather rare affection by many writers, this view has not been corroborated by many recent contributions to the subject. Among the older reports mention may be made of the statistics of Limacher¹ in Berne, who found forty-four sarcomas and thirty-eight carcinomas in 7641 autopsies, Chiari in Prague, fifty-five sarcomas and eleven carcinomas in 7700 post-mortems, giving reason for the assumption that malignancy was not only rare but had a tendency to occur largely in goitrous regions. Balfour,² on the other hand, recently records 103 cases of cancer in 6359 cases of goitre, exclusive of the exophthalmic group, a percentage of 1.6 per cent. These cases occurring in a distinctly goitrous region (Minnesota) are to be contrasted with a decidedly higher percentage of 4.6 per cent found in our own cases developing in Pennsylvania, where goitre is decidedly uncommon. Porter reports a cancer incidence of 3.64 per cent, but adds that considering the percentage of cures (100) one is led to question the diagnosis in some, at least, of his cases.

Although Bloodgood³ noted a high percentage of malignancy, nine cancers and one sarcoma in 148 thyroid lesions, the association of previous goitre was not observed, and there was a history of goitre earlier in life in one case only. Taking into consideration the slow growth in some cases of thyroid cancer, Chambers¹⁴ thinks it probable that in many instances the condition is rather one of a continuous slow development of a malignant goitre, rather than a malignant one superimposed on a benign growth.

The majority of writers, however, lay much stress upon the etiologic significance of benign growths in the development of cancer. Balfour² states that such an association is almost invariable, Delore⁴ in 82 per cent of the cases, Muller and Speese⁵, 59 per cent, while Kocher,⁶ Langhans,⁷ Lucke⁸ and Carrel-Billard⁹ all emphasize the common association of benign and

* Read before the Philadelphia Academy of Surgery, May 2, 1921.

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malignant struma That preëxisting goitre is a factor in the development of sarcoma is noted in Lartigau's¹⁰ analysis of fifty-one cases in which there was a history of goitre in thirty-five instances

In many reports in which the history of benign goitre has not been elicited, it is probable that it was not noted because a careful examination was not made, or the patient had paid little or no attention to an enlargement common and of little significance, particularly in goitrous regions

While the disease is considered more prevalent in goitrous districts, Berry¹¹ states that even in cases in which there is no history of preëxisting goiter it will be found often, upon examination after removal, that the tumor contains cysts, points of calcification, or some similar evidence of former disease

Ehrhardt¹² believes the inflammation, calcification, cystic formation, hemorrhage and necrosis found in old goitres, whether clinically apparent or not, tend to act as chronic irritants In such degenerated areas the epithelium is frequently so atypical that a diagnosis between a benign growth and early malignancy is often very difficult, and he further believes that in this atypical development lies the relation of previous disease of the thyroid to malignancy Other etiologic factors to be considered are previous inflammation of the gland (de Quervain¹³), trauma (Cornil), and in two cases Kaufmann found cancer to be closely associated with pregnancy

The material examined comprises 426 lesions of the thyroid gland, in which cancer occurred nineteen times and sarcoma three times In addition six other cancer cases from outside sources have been studied in the laboratory, making a total of twenty-eight malignant thyroid tumors

Reviewing the clinical history of these cases, the gross and microscopic examination, cancer was found associated with the following diseases Colloid adenoma, ten, foetal adenoma, four, papillary cystadenoma, three, colloid goiter, four, colloid goitre and sarcoma, one

In five cases a history of goitre preceding the development of cancer could not be elicited and evidence of previous disease could not be found in the pathological examination In one of the three sarcomata, a preëxisting colloid goiter with marked fibrosis acted as the predisposing factor

The study shows, therefore, that in twenty-eight cases of malignancy (twenty-five carcinoma, three sarcoma) a preëxisting goitre was present in twenty-two instances, a percentage of 78.5 per cent In two cases only were secondary operations performed We were unable to ascertain the nature of the tissue removed, as both were done in hospitals some distance away From the history, partial thyroidectomy presumably was performed The question naturally arises, in these cases, as to whether a small adenomatous nodule being left behind may have been stimulated by the traumatism of the operation to undergo malignant degeneration, and such instances naturally suggest the thorough exploration of both lobes of the thyroid for such adenomatous nodules, and of course, their thorough extirpation

In the following table is shown the duration of the primary tumor before

the appearance of symptoms indicating malignant degeneration. The average time of twelve and six-tenths years clearly demonstrates that early operation for removal of the benign lesion would have prevented the development of cancer in the majority of cases: three months, one case, three years, one case, six years, two cases, ten years, three cases, thirteen years, one case, fifteen years, six cases, eighteen years, one case, twenty years, one case.

Further study of the cases shows that symptoms indicating toxic manifestations were present in five. These symptoms, in one instance only, were of a severe nature, the majority of the patients complaining of tremor, tachycardia and loss of weight.

Change in the physical characteristics of the primary benign goitre was the chief symptom, fourteen of the patients stating that enlargement and increase in consistency of the growth were the first symptoms noted. Pain of a neuralgic and radiating type was first noted in five instances, dyspnoea in five, dysphagia in two, hoarseness and cough in one each.

The diagnosis of thyroid cancer in the early stages is difficult or impossible, the majority of our cases were only discovered after operation or in the course of the pathologic examination of the specimen. This corresponds to Balfour's experience, in which 18 per cent of the cases only were positively diagnosed clinically as cancer, and in 46 per cent the condition was not even suspected or was only discovered after operation.

The number of cures would naturally be greatest in the cases discovered after operation, and the eight cases of which we have record of no recurrence are all in this class, and represent, of course, malignancy in an early stage, and therefore a curable one. The percentage of cures in this group is fairly high and the fact that there has been no recurrence in a large percentage of the cases in various clinics, indicates that complete extirpation of the thyroid is not necessary when malignancy is found in an adenomatous nodule, providing there has been no extension beyond the capsule of the gland.

In Balfour's statistics the operative mortality was 6 per cent, 47.6 per cent died within a short time of recurrence, 11 per cent have recurred, 35 per cent have had no recurrence, many of these being of short duration. The operative mortality and permanent results have been much improved since 1897, when Carrel-Billard quotes in 110 observations an operative mortality of 53.6 per cent (13.6 per cent immediate, 40 per cent within a few days), and 10 per cent of cures.

In discussing the etiology of the adenocarcinomata, Kocher⁶ states that the tumor begins in a circumscribed area, pushing the healthy gland to one side. Whether this area is the starting point of the cancer, or whether its origin is to be sought in the growth of embryonal cells or in small nodules of degenerated adenomatous tissue, is difficult to determine clinically. The cancer rarely involves the entire gland, usually one lobe only, and the isthmus in very exceptional cases. The growth may develop in accessory thyroid

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tissue and the main gland remain free Langhans believes that the growth originates in foetal cells, which, remaining latent for many years, under some form of irritation take on active growth and develop The factors which are active in the production of simple goitre may be the ones which call forth the active and later malignant degeneration of these embryonal cells, which have a greater tendency to grow in parts already the seat of pathological changes

It is significant that Balfour mentions seven cases in which malignancy occurred in an enlarged thyroid that had been treated previously by injections of various irritants and by the application of absorbents, convincing examples of the fact that chronic irritation is the chief factor in inducing malignant changes and should serve as an argument against dangerous methods of treatment

The study of hyperplasia and carcinoma of the thyroid in the salmonoid fishes by Gaylord,¹⁵ on account of the great similarity in the changes in the organ of the fish to those occurring in mammals, seems likely to throw important light upon the origin of certain structures which have been the subject of extensive study in the thyroid of mammals

According to Michaud, adenomatous tumors are formed by proliferation of the normal structures of the thyroid The description given for the development of such adenomata in the mammalian thyroid is exactly like the beginning changes leading to carcinoma of the thyroid in fishes, and it is evident from this study that the changes in the thyroid are brought about by the action of some agent working focally upon the epithelium of normal vesicles, and thus we can clearly exclude all possibility of embryonic rests playing a part in the genesis of circumscribed adenomata or cancer

Endemic goiter and carcinoma of the thyroid in the Salmonidæ are to be regarded as one and the same thing Viewed in the light of modern cancer research, it appears to Gaylord that the term carcinoma is in every respect the most suitable The first positive results obtained in dogs and rats must for the present be classed as diffused parenchymatous struma. Adenomata have been produced in rats, and, as it is well known that such adenomata of the thyroid develop in what is called cancer of the thyroid, it appears quite possible that further experiments may show that in mammals experimental parenchymatous and nodular struma are but the early stages of the process which is called cancer of the thyroid

Cancer of the thyroid may manifest itself as a primary tumor by changes in the physical characteristics of an old goitre, or by symptoms due to involvement of adjacent structures, *i.e.*, œsophagus, trachea, etc In rare instances, according to Carrel-Billard, initial symptoms of altered thyroid function precede local manifestations by several weeks or months

As a rule rapid increase in size of a goitre previously quiescent is the first and most common symptom of malignancy

The growth becomes irregular and there is a decided increase in its

consistency These symptoms are regarded as so important by Bloodgood⁸ that he urges immediate operation in every asymmetrical enlargement of the thyroid in individuals over thirty years of age, for only by following this rule will surgeons eradicate malignant tumors before they have produced inoperable metastases

Carrel-Billard described three types of thyroid enlargement due to cancer The acute variety, in which sudden increase in size is followed by rapid invasion of the surrounding parts, is usually fatal within a few weeks The cases occur in comparatively young people and there may be no history of preëxisting tumor

Cancer in a non-goitrous thyroid is very rare The patient usually discovers a small movable tumor, which may appear in any part of the gland The growth, at first slow, with no alarming symptoms, suddenly becomes active, infiltrating the thyroid and surrounding parts, with the characteristic symptoms of malignancy The acute enlargement in young people, at a time when physiologic activity of the gland subjects it to sudden changes, is not so serious as in the old Enlargements, therefore, in those over thirty or forty should be regarded as a suspicious symptom Unfortunately the appearance of a nodule is not always demonstrable, and the cancer may be represented by a small growth embedded in and surrounded by normal thyroid tissue, there being no appreciable increase in size of the gland This type called the "latent form" is very insidious in its course, and there is nothing to show that the thyroid has undergone malignant degeneration until visceral or osseous metastases appear In some instances the development of the cancer is preceded by severe neuralgic pains, which radiate to the head, neck, or arms, and aid is sought for the neuralgia or hoarseness without a tumor having been noted by the patient

In the more common instances in which cancer develops in thyroids the seat of goitre, a subacute course is followed The period between the primary enlargement of the goitre and before extracapsular extension of the cancer, the period when operation should be performed because metastasis or infiltration has not occurred, is difficult to estimate In Carrel-Billard's cases from two to six months elapsed from the initial enlargement until surgical aid was sought, and Kocher states that, as a rule, within three to nine months malignant tumors extend beyond the thyroid capsule

Either before or after the appearance of a malignant tumor, the patient may complain of symptoms analogous to those of toxic goitre In numerous cases, tachycardia, tremor, palpitation and certain metabolic disorders may be present without a definite tumor, this may appear later and take on the definite changes of malignancy The development of cancer, according to Carrel-Billard, alters the thyroid secretion, so that increase or decrease of thyroid function may appear under variable conditions The intoxication of cancer manifests itself in different ways and varies in its nature and intensity From mildly toxic symptoms, various grades are met with up to acute intoxication with fatal cachexia developing within a few weeks or months

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In Carrel-Billard's series of eighty-three cases, twenty-six patients gave a more or less clear picture of toxic manifestations, the same symptoms were noted five times in our cases. The reaction of the organism to the toxæmia of thyroid cancer is classed under three heads (1) Hyperæmia, (2) Symptoms of Basedow's Disease, (3) Disturbance in Nutrition

1 A rise in temperature $38-38.5^{\circ}$ to 39° C may precede the appearance of the tumor. The patient becomes cachectic, and only after the lapse of some weeks is the cause (cancer) demonstrable. Fever, more constantly found in sarcoma than in carcinoma, is regarded as a symptom of altered thyroid function

2 Symptoms of exophthalmic goitre, not always characteristic, have been discussed above

3 Disturbances in nutrition are manifested at first by loss in weight, a definite cause of which is not always apparent. Urinary disturbances, increase or decrease, are frequently encountered

Sarcoma likewise may produce toxic symptoms as was noted by Tillaux,¹⁶ in which typical symptoms of exophthalmic goitre, except tachycardia, were noted. Following extirpation of the sarcoma, the toxic symptoms disappeared, the patient died later of lung metastasis

While hypersecretion of the thyroid is thus seen to be fairly common in cancer, the absence or lack of secretion is exceedingly rare, for there is usually sufficient normal thyroid tissue to carry on the function of the gland. It should be pointed out that whereas the development of cancer may be attended by alteration of thyroid secretion and the production of toxæmia, so far as we have been able to ascertain, a true exophthalmic goitre has never been known to undergo carcinomatous degeneration

CONCLUSIONS

1 Benign tumors of the thyroid gland preceded the development of malignancy in practically all cases

2 Cancer is found more frequently associated with colloid and foetal adenomata, and is relatively uncommon in simple colloid goiter

3 Thorough exploration of both lobes of the thyroid is indicated to prevent leaving behind a small adenomatous nodule from which malignancy may develop at a later date

4 When cancer is present clinically and diagnosis easy operative measures offer but little hope. The majority of cases are discovered in the course of operation or in pathologic examination. The greater number of such cases are cured by operation (70 per cent)

5 Early operation in all goitres is indicated to prevent malignant degeneration, which on an average in our cases has occurred twelve and six-tenths years after the appearance of the benign goitre

6 Toxic symptoms occasionally occur in cancer, may precede the appearance of the malignant tumor and obscure the diagnosis

7 Enlargement of a preëxisting goitre and increase in its consistency are the first symptoms of carcinomatous degeneration of a benign struma

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TRAUMATIC CHYLOTHORAX*

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I FEEL justified in presenting this case not only because of its extreme rarity but because I believe my experience may prove of value to others

CASE REPORT—R A, white male, aged thirty-five years, entered the University of Virginia Hospital January 4, 1919

Family History—Unimportant Previous History—Unimportant Present Illness—He was admitted to the Western State Hospital for the Insane on December 20, 1918 The next morning at breakfast he secreted a dull case knife and was found half an hour later with his throat cut He had shoved the knife into the suprasternal notch as far as he could, moved it crosswise and up and down, said he put it in three different times When Doctor DeJarnette, to whom I am indebted for this history, reached him he was lying on the bed with blood running from the wound and into the lungs, the trachea apparently being cut His head was lowered and the blood soon began to run out of his lungs This helped his breathing very much and the bleeding soon ceased He was given a cup of water, which he drank with comfort, and the œsophagus was thought to be uninjured He was given a diet of milk and eggs and was thought to be doing nicely until December 23rd, when he began to strain and cough and tried to vomit, expelling a good deal of "milk" (chyle) from the wound in his neck. On December 28th, the left pleural cavity was aspirated at the angle of the scapula and three quarts of "milk and eggs" removed The fluid had no bad odor and was not curdled at all Before aspiration the slightest movement would exhaust him and he could scarcely breathe, panting like a dog in the summer time Two days later the right pleural cavity was aspirated and thirty ounces of fluid, similar to that described above, was removed It was thought that his œsophagus had been cut and that his diet of milk and eggs had been running into the pleural cavities instead of into his stomach An X-ray examination was made of the œsophagus, after inserting a tube filled with barium sulphate, and the tube seemed to enter the stomach, but in spite of this it was decided not to feed him for three days hoping the wound in the œsophagus might heal He was given saline and nutrient enemata and allowed to wash his mouth frequently with water, but was not permitted to swallow anything for three days At the end of that time it was noticed that his left pleural cavity had filled up again and it was found that he had been drinking water He admitted that he had drunk three pints, but he was aspirated on January 2, 1919, and one gallon withdrawn This fluid was highly tinged with milk, probably from the residue left after former aspirations There was no further effusion in the right pleura after the first tapping On January 4, 1919, the left pleural cavity was again aspirated, removing five pints of "milk and eggs", which was thought to have been put in the stomach through the tube This improved his breathing but he complained considerably of hunger and thirst He was brought to the University of Virginia Hospital the same day, i e fourteen days after the injury, and the following note was made Patient is a large man and says that before injury he weighed 170 lbs, but he has evidently lost a great deal of weight and apparently now weighs not over

* Read before the Virginia Chapter of the American College of Surgeons, Richmond, Va., April 15, 1921

num between the aorta and the vena azygos major As it ascends it lies on the bodies of the seven lower thoracic vertebræ with the pericardium, œsophagus, and the arch of the aorta in front. At the level of the fifth thoracic vertebra it inclines toward the left side, ascends behind the arch of the aorta on the left of the œsophagus, and behind the first portion of the subclavian artery At the level of the seventh cervical vertebra it turns outward and then downward over the left pleura, subclavian artery and scalenus anticus, and empties into the venous system at the junction of the left internal jugular and subclavian veins " Although it has been proved anatomically in only a few instances, it is thought by many that the thoracic duct may anastomose with the right lymphatic duct and the azygos veins This seems to be borne out by clinical experience, namely the absence of ill effect when the duct is ligated during operations in the neck, and Warschauer ⁸ has even suggested the advisability of intentional ligation of the duct in all operations in the neck in which it might be endangered It seems to me that the absence of chylothorax following ligation of the duct in the neck and its occurrence in certain pathological lesions of the duct might be explained on the ground that in the latter conditions the collaterals are often involved

Injuries of the thoracic duct in the neck occurring during operations in this region have been thoroughly discussed in recent years by Zesas ⁹ and by Harrison ⁵

In 1908, F A Baldwin ¹ collected forty-seven cases of true chylothorax of which thirty-one were males and ten females and whose ages varied from two to sixty years The etiology of these cases was given as follows Traumatic, sixteen, pressure upon the duct by new growths or tuberculous lymph-nodes, nine, secondary growths in duct, nine, thrombosis of left subclavian vein, four, proliferating lymphangitis, two, aneurismal dilatation of duct, two, thrombosis of duct, one, result of removal of carcinomatous glands of neck, one, obstruction of radicles of duct from inflammatory thickening of mesentery, one, mitral disease, one, filariasis, one Of this series 34 per cent were traumatic in origin

In 1912, Zesas ¹⁰ collected twenty-four cases of non-operative injury of the thoracic duct, including wounds of the duct in the neck The injuries of the duct were thus produced Four times by gunshot, twice by a cut or stab, six times by fracture of ribs or collar-bone, once by vertebral fracture, three times by fracture of the ribs and vertebræ, seven times by "contre-coup" In seventeen of these cases chylothorax was present, in one chylo-ascites The chylothorax was on the right side in ten cases, on the left side in four cases and bilateral in three cases

The more frequent occurrence of chylothorax on the right side is quite natural considering the anatomical relations of the duct and the right pleura, the right pleura is closely approximated to the duct and forces which affect the duct are apt to injure both structures at the same time Some authors, notably Hammesfahr, think that as a result of the negative pressure in the

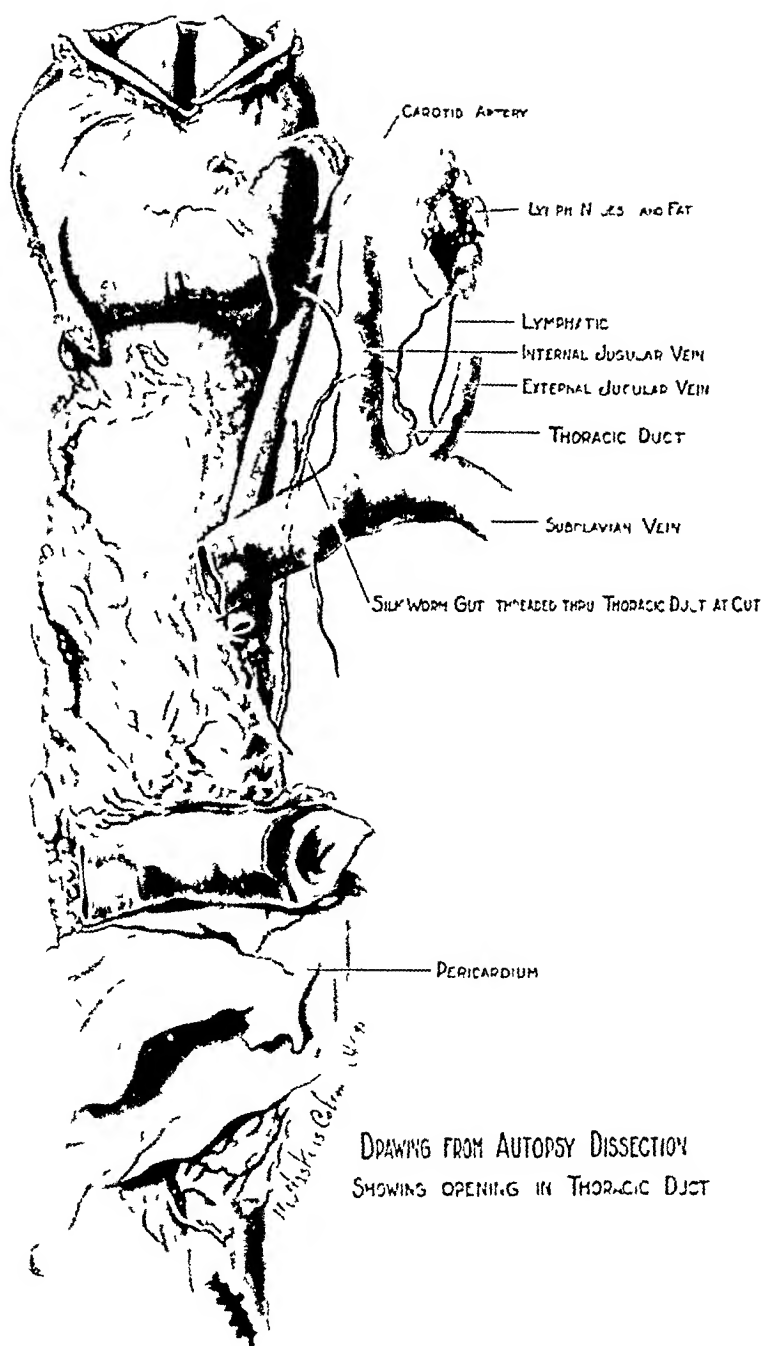


FIG. 1.—Autopsy dissection showing opening in thoracic duct.

chest chyle can escape into the pleura from the mediastinum through the normal intercellular spaces between the endothelial cells. It seems to me that this is the only way in which the presence of chyle in the right pleural cavity can be explained in my case as there was no injury of the right pleura.

Most cases of traumatic chylothorax are due to violent, blunt force (blows and crushes) exerted upon the chest and back, and many of the cases are associated with fracture of the ribs or vertebræ. In some cases, however, there is no evidence of bony injury and the rupture of the duct is probably due to alterations in the intrathoracic pressure or to overstretching of the duct, the state of fulness of the duct possibly being of etiological importance.

Chylothorax due to stabs and gunshot wounds is extremely rare. This is to be expected considering the relations of the thoracic duct to the great vessels and heart, such an injury of the duct is very apt to be associated with a fatal wound of these structures. I can find on record only one case, besides my own, of chylothorax due to stab. Zesas has recorded two cases of chylothorax due to gunshot wounds and I have found two other cases which occurred during the recent war and were reported by Elliott and Henry.² These two cases occurred in the same base hospital in one month, but were the only ones in 600 samples of hæmothorax fluid examined by the authors and this laboratory figure covered far more than 1000 chest wounds. In both cases the missile passed obliquely across the apex of the thorax behind and under the left subclavian artery.

The clinical manifestations of chylothorax are those of a simple pleural effusion. Diagnosis made by aspiration and then the fluid may be mistaken for pus. A careful microscopic and chemical examination of the fluid will decide. There are seldom any subjective symptoms in non-traumatic cases except dyspnoea and weakness. Elliott and Henry think the following points may help in the differentiation of chylothorax and hæmothorax due to war wounds. In the former the effusion is more apt to be on the left side and continues to increase steadily and rapidly on the third and fourth days, causing progressive cardiac and respiratory embarrassment. Such an increase is rarely seen with an ordinary sterile hæmothorax where the bleeding is either fatal or ceases within the first twenty-four hours. It may, however, occur as the result of infection of a hæmothorax. A chylous effusion, even if infected, will not be accompanied by high fever because the patient's nutrition is profoundly impaired.

The prognosis of traumatic chylothorax is very grave and in the cases collected by Zesas the mortality was slightly over 50 per cent. Death is usually due to exhaustion from the loss of chyle. Hahn's case, in which twenty-nine litres of chyle were aspirated in the course of twenty-six days, died, but the case of Dietze, in which twenty-seven litres were removed in forty-two days, recovered.

As regards treatment it may be said that radical surgery, i.e., attempts to find and close the opening in the duct, is hardly practical. Aspiration should

only be done when the pressure symptoms are very marked as the relief of pressure may increase the leakage from the duct Thoracotomy is not recommended, though in the case of Helferich the leakage of chyle ceased after the thoracotomy, whereas it had not done so following previous aspirations Some have suggested cutting down the fats and increasing the sugar in the diet to diminish the flow of chyle Hall and Morgan ⁴ claim that all that the injured duct needs for recovery is rest, which is secured by exclusive rectal feeding, the food thus given being absorbed by the colonic lymphatics, which pour their contents into the general superficial and peripheral lymph channels instead of the lacteal system I hardly think that experience will bear this out In our case we intended to inject the aspirated fluid into a vein but the idea was abandoned when the fluid was found to be infected

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AN ANOMALOUS PORTAL VEIN WITH ITS SURGICAL DANGERS

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ANOMALOUS vessels are not uncommon but the vein herein described I think to be of such exceptional rarity as to warrant reporting. The condition recorded in this short communication was discovered in the body of a male dissecting-room subject, aged sixty, in the Laboratory of the Anatomical Department of the University of Texas. It has proven to be a remarkably interesting case of anomalous portal vein. A search through the files of the *British Journal of Anatomy and Physiology* and of the *American*

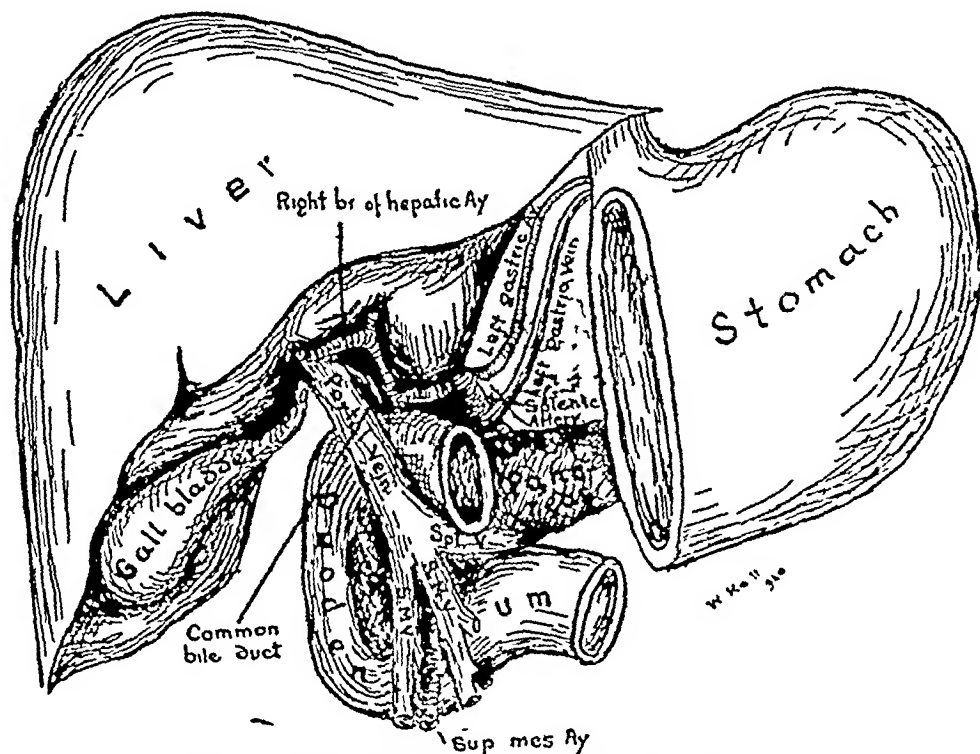


FIG 1.—Drawing of case described from tracing made on glass.

Journal of Anatomy for the last five years did not reveal notice of an abnormal vessel like the present specimen. This anomaly is of special interest to surgeons because of its unusual and exposed position in connection with operations upon the common bile-duct.

The abnormality is formed as follows (Fig 1). A number of tributaries issue from the hilum of the spleen which unite to form the splenic vein. The vessel then runs from the left toward the right, passing obliquely posterior to the middle portion of the body of the pancreas. It emerges from underneath the body of the pancreas just below the neck of the organ,

continuing along the summit of the duodeno-jejunal flexure. A little beyond the point immediately anterior to the head of the pancreas it is joined by two rather large veins coming upward from below in the root of the mesentery of the small intestine. These two veins, which represent the superior mesenteric vein, pass upward anterior to the horizontal portion of the duodenum and are returning the blood from the small intestines, receiving all the tributaries from this portion of the gut which correspond to the rami intestinales of the superior mesenteric artery. The portal vein formed in this manner anterior to the head of the pancreas then courses upward anterior to the upper flexure of the duodenum. At the upper border of the duodenum the vessel enters the right free border of the gastro-hepatic omentum (lesser omentum) and passes thence to the right extremity of the porta hepatic antero-lateral to the common bile-duct, and the hepatic artery. It will thus be seen that the vein lies in front of the duodenum, common bile-duct, and hepatic artery instead of behind them, as is usual, and that in operations upon the common bile-duct or glands in this region the danger to this great vein is very serious, especially as the anomaly is so unexpected.

The explanation of the anomaly in the position of this vessel must be preceded by an account of the development of the portal vein. It will be remembered that this vessel is formed out of the proximal portions of the two vitelline veins of the embryo which empty into the sinus venosus (Fig 2). These two vessels begin by the union of radicles in the wall of the yolk-sac. In Fig 2 the left vitelline vein is shown arising in this way. The vessel next courses in the dorsal mesentery of the fore-gut and entering the ventral mesentery it passes into the sinus venosus. It is also shown in this figure that in the dorsal mesentery the tributaries of the portal vein, the splenic which drains the fore-gut, the superior mesenteric which drains the mid-gut, and the inferior mesenteric which drains the hind-gut are developed in this situation as tributaries of the vitelline veins. In order to understand the changes taking place which lead to the formation of the normal portal vein, it must be kept in mind that the duodenum forms at first a free loop the right lateral surface of which later becomes attached to the posterior surface of the abdominal wall by a process of physiological inflammation. This loop is situated between the two vitelline veins (Fig 3). The two vitelline veins have become united by three cross anastomoses with each other in such a manner that there is formed about the gut a cephalic and a caudal venous ring. These connections have the following positions: one transverse connection (a) in the liver, a middle one (b) behind the duodenum, and the third (c) caudal to the duodenum.

The development of the normal portal vein from the sides of these two venous loops with their cross anastomoses takes place in this manner: the portal sinus, which occupies the transverse fissure of the liver, is formed out of the cranial transverse anastomosis (a), the part of the vein in the right free margin of the gastro-hepatic omentum (lesser omentum) and behind the first portion of the duodenum is formed from the right side of the cephalic

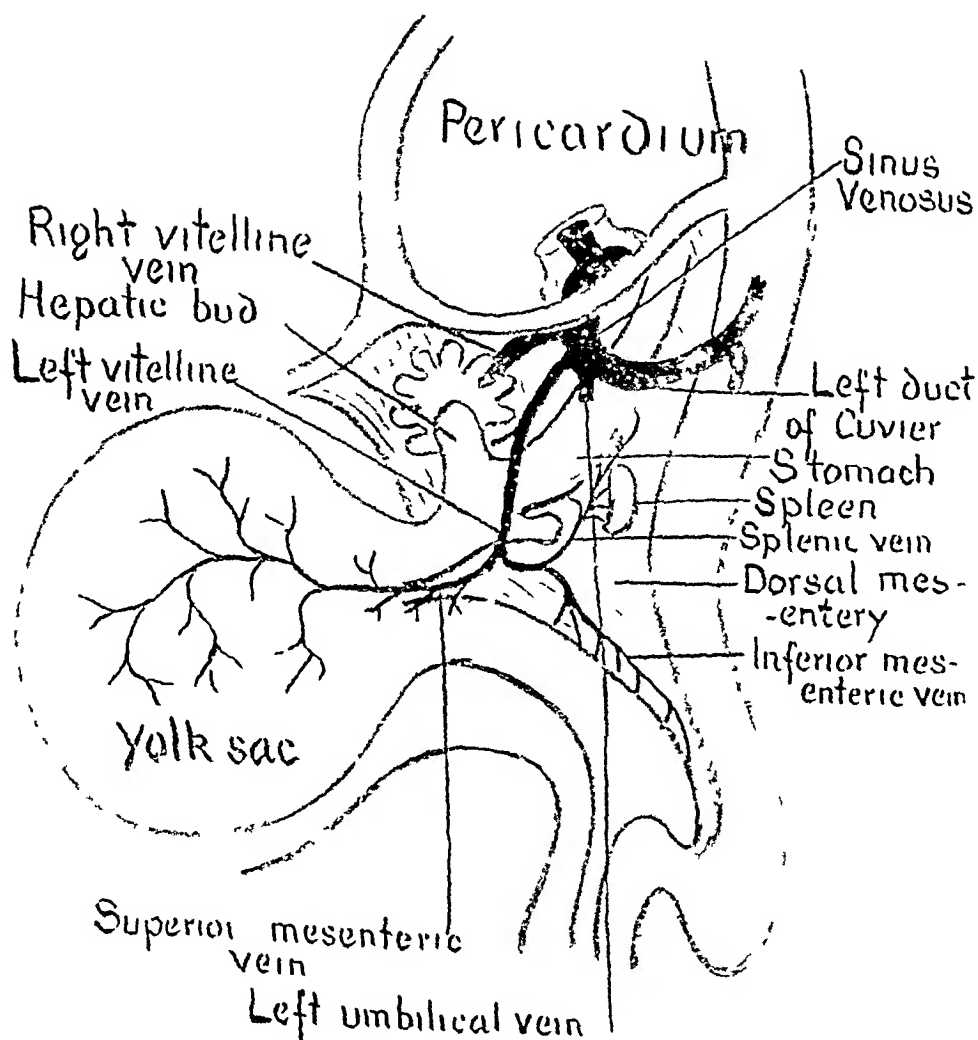


FIG. 2.—The left vitelline vein of an embryo of *Xenopus laevis*.

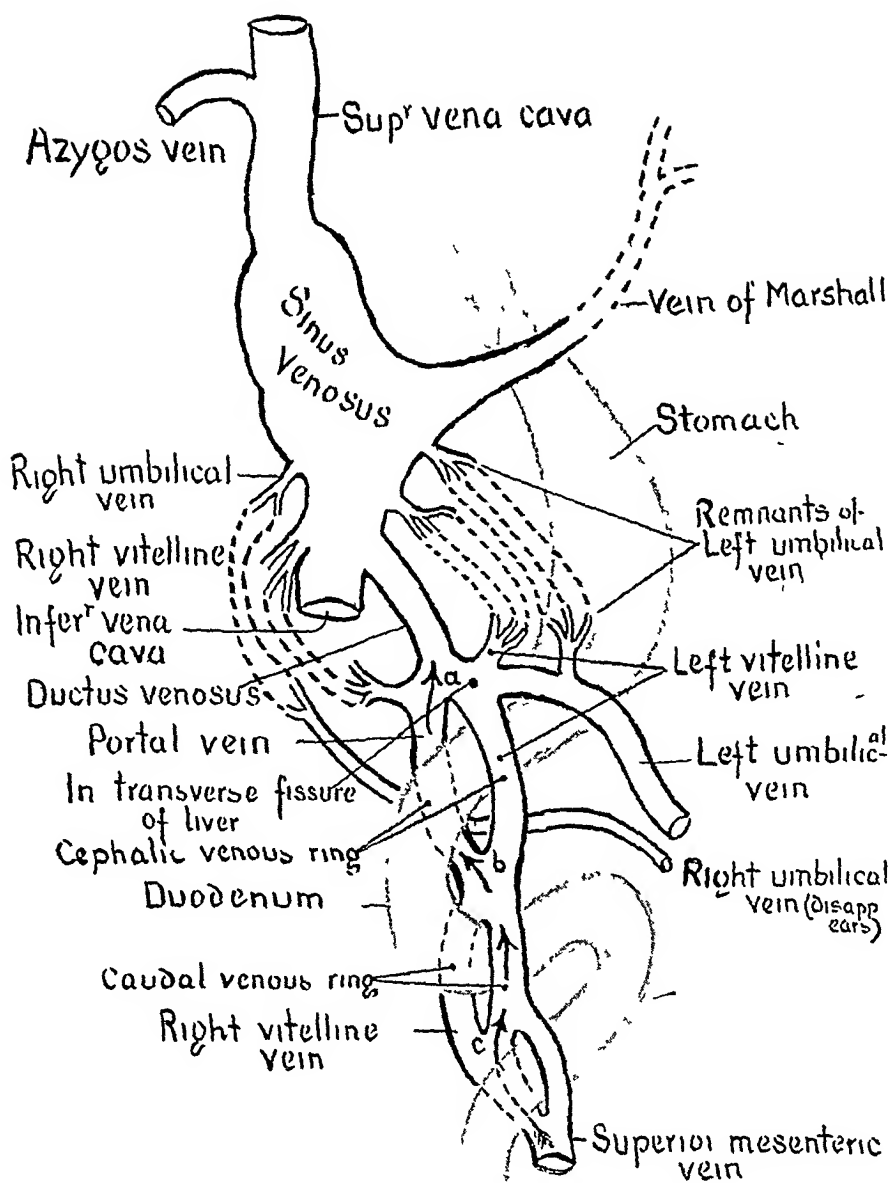


FIG 3 —Diagram showing the formation of the ductus venosus and the fate of the umbilical and vitelline veins. The arrows show the parts of vitelline veins which become the portal vein (after Keith) (a) Cranial transverse anastomosis (b) Middle transverse anastomosis (c) Caudal transverse anastomosis

ANOMALOUS PORTAL VEIN

loop (right vitelline vein), while the left limb of this loop atrophies and disappears, the middle anastomosis (*b*) represents the commencement of the portal vein immediately posterior to the neck of the pancreas, finally, the left limb of the caudal loop persists as the terminal part of the superior mesenteric vein, which lies anterior to the horizontal portion of the duodenum, and the right limb of this loop disappears

In our specimen the right limb of the cephalic venous loop which surrounds the first portion of the duodenum degenerated, contrary to the rule, while the left limb persisted, with the result that the vein in this part of its course is lying directly anterior to this stage of the duodenum

MALIGNANT NEOPLASIA IN THE GALL-BLADDER

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NOTWITHSTANDING the fact that malignant conditions of the gall-bladder have been well described in the literature, our recent observations with a large series of cases differing somewhat from those in the literature seem to justify a review of the subject

A REVIEW OF THE LITERATURE

Three cases of cancer of the gall-bladder were reported before 1800, two by de Stoll in 1777 and one by Halle in 1786 Baillie reported a case in 1794, but the diagnosis was questioned because the lesion resembled tuberculosis From 1800 to 1850 seven cases were reported Durand-Fardel, in 1840, were the first fully to describe the condition In the latter half of the nineteenth century many contributions to the subject were made by English, French, German, and American writers, among the most important of which may be mentioned those of Rolleston, Villard, Courvoisier, Zenker, Fütterer, Musser, Ames, and Smithies, representing the medical aspect of the subject, and of those of Mayo-Robson, Moynihan, Quenu, Kehr, Erdman, Deaver, and W J Mayo from the surgical and prognostic aspects

Fawcett and Rippmann, in 592 necropsies in cases of gall-stone, found malignant conditions of the gall-bladder in forty-eight cases Dr W J Mayo has stated that cancer occurred in eighty-five of 3908 operations on the gall-bladder and biliary passages in the Mayo Clinic Erdman found the incidence of cancer in this organ to be 6.7 per cent in 224 cases of cholecystitis in which he operated from 1917 to 1919 Deaver found 1.6 per cent malignancy in 1000 operations for gall-stones, and Smithies has reported 2.3 per cent malignancies in 1000 operations on the gall-bladder

PATHOLOGY

Ziegler believes that carcinoma of the gall-bladder is of the cylindrical epitheliomatous type which takes the form of a papillary or fungous tumor, or of a cancerous ulcer MacCallum believes that the malignancy takes the form of adenocarcinoma or epithelioma Rolleston has found the condition to consist chiefly of carcinoma, which may be of the columnar or spheroidal-cell variety and the cells may undergo colloid degeneration The

tumor may be papillomatous or invasive. Through metaplasia a squamous-cell carcinoma may occur. He cites references to twenty-two cases of the squamous-cell type. Primary sarcoma is considered exceedingly rare. Rolleston cites only fourteen references to this type of growth. It is believed that the growth originates in the glands in the wall of the gall-



FIG. 1 (47709).—Papillary carcinoma of the fundus of the gall-bladder.

bladder or in its mucous membrane. MacCarty and Rolleston believe that both carcinoma and epithelioma arise from the mucous membrane which lines the gall-bladder.

Rolleston states: "It may be concluded that carcinoma, whatever its form, arises from the mucous membrane as a whole, and no statement that either form of carcinoma arises exclusively from the surface epithelium of



FIG 2 (47799) —Carcinoma shown in Figure 1 $\times 50$



FIG 3 —(47799) —Carcinoma shown in Figure 1 $\times 500$



FIG 4 (233246) —Papillary carcinoma of the gall-bladder



FIG 5 (233246) —Carcinoma shown in Figure 4 $\times 50$



FIG 6 (197895) —Colloid carcinoma of the gall bladder



FIG 7 (197895) —Carcinoma shown in Figure 6

MALIGNANT NEOPLASIA IN THE GALL-BLADDER

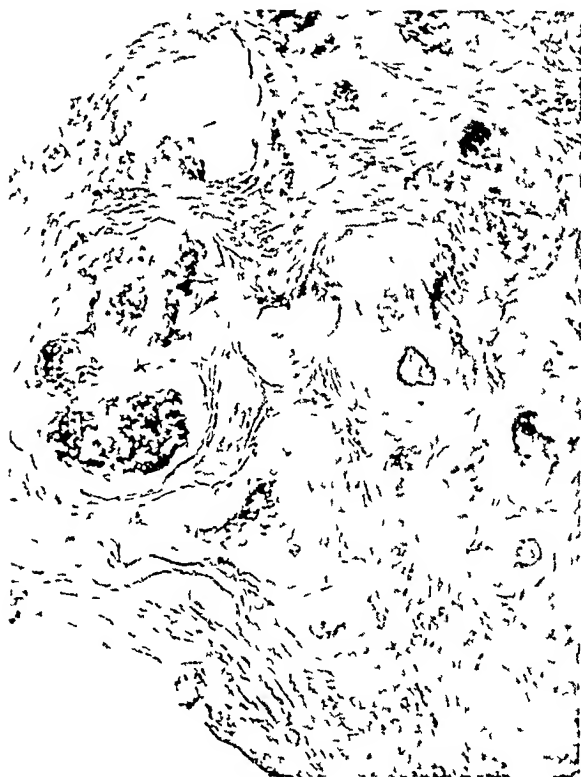


FIG 8 (197895) —Carcinoma shown in Figure 6 \50



FIG 9 (181245) —Diffuse carcinoma of the gall-bladder

the gall-bladder or from the epithelium lining the glands is justified. The growth is found most commonly in the fundus, although it may occur in the neck of the organ, or be diffuse in form." Futterer classifies his cases as follows: Seventeen in the fundus, thirteen in the neck, eight in the anterior wall, and seven in the posterior wall.

ETIOLOGY

Malignancy of the gall-bladder is shrouded in the same cloak of mystery as is cancer in general. Many writers believe that the chief causal factor is the local irritation of gall-stones, which are present in a large percentage



FIG 10 (181245) —Carcinoma shown in Figure 9 $\times 50$

of the reported cases. Mussey found stones in primary malignant disease of this organ in 69 per cent of cases, Futterer in 70 per cent, Winton in 81 per cent, Zenker in 85 per cent, Courvoisier in 91 per cent, Siegart in 95 per cent, Janowski in 100 per cent, and Deaver in 89 per cent. Beadles found sixty-four cases of secondary malignancy, with stones in two instances. Siegart found stones in 15 per cent of secondary malignancy. Whether the stones are the cause or the result of the growth has been widely discussed. Lutton, Lancereaux, Lang-Henrich, and Forster favored the view that the growth precedes the stones. It was suggested that the neoplastic condition causes stagnation and inspissation of the bile with a resultant formation of stones. It is now generally conceded that the stones precede the growth

MALIGNANT NEOPLASIA IN THE GALL-BLADDER

Various English writers claim heredity as a factor in from 11 to 17 per cent Schueppel denies this In Smithies' series a history of heredity was found only once

AGE AND SEX INCIDENCE

Cancer of the gall-bladder shows a predilection for females, Zenker found 72.9 per cent in women, Naunyn 83 per cent, Musser seventy-five females to twenty-three males Smithies, on the other hand, reported sixteen males to seven females The condition is usually observed between the ages of fifty and seventy Sherrill gives the average age as fifty-four and five-tenths years, Smithies as fifty-nine years, and in Musser's cases the ages were as follows

Years	Patients
1 - 10	1
11 - 20	0
21 - 30	1
31 - 40	9
41 - 50	19
51 - 60	29
61 - 70	19
71 - 80	14
81 - 90	1

Ames reported the case of a boy aged four

The clinical picture in our cases does not differ from that described in the literature Lancereaux divided malignancy of the gall-bladder into a biliary form characterized by belching, abdominal cramps, dyspepsia, jaundice, abdominal mass, and fever, and an hepatic form with an insidious onset, short duration, vague abdominal pains, weakness, diarrhoea or constipation, rapid enlargement of the liver, and occasional slight jaundice Guyot added three other groups, chiefly dependent on the symptoms produced by adhesions of the malignant gall-bladder to other organs, pseudopyloric symptoms, intestinal symptoms, or symptoms due to perforative peritonitis. Rolleston divides the cases into those in which the symptoms are associated with preexisting cholelithiasis, those in which the symptoms are due to the local effects of the disease, and those in which they are due to invasions of the adjacent parts by the growth and to metastasis in the liver, peritoneum, or elsewhere W J Mayo mentions the following diagnostic clinical points in connection with the diagnosis A hard tumor in the region of the gall-bladder, absence of rigidity unless the peritoneum is involved, progressive loss of flesh and cachexia, a nodular tumor if the liver is involved, and jaundice if the ducts are involved

SURGICAL TREATMENT

Bardenheuer was probably the first to extirpate the gall-bladder for cancer. Hoehenegg next performed the operation, his patient had not had a relapse at the end of eight months. When the tumor is confined to the gall-bladder cholecystectomy is generally conceded to be the operation of choice. In some cases a portion of the liver may be removed, as was first advised by Mayo-Robson, although when it is necessary to remove a large portion, poor results may be expected. Cotte speaks of palliative and radi-



FIG. 11 (35874) —Diffuse carcinoma of the gall bladder with adjacent liver tissue

cal operations, that is, cholecystostomy, which should be reserved for the badly infected cases, or for those in which there is considerable retention in the gall-bladder, and cholecystectomy with the removal of the neighboring lymphatic glands and the excision of adjacent liver tissue. The results of surgical treatment of malignancy of the gall-bladder as gleaned from the literature are far from satisfactory. W. J. Mayo, in 1910, reported five patients alive after two years. In these a preoperative diagnosis of malignancy was not made. One patient whose diagnosis was made preoperatively lived more than one year. Smithies reported the cases of two patients who

MALIGNANT NEOPLASIA IN THE GALL-BLADDER

have remained well more than four years, all the other patients in his series died within eight months. Quenu, in ninety-three collected cases, reported results as follows: Death in less than three months, seventeen, death between three and four months, seven, death between four and six months, six, death between six and eight months, eight, death between eight and twelve months, one, death at the end of one year, three.

Friedham reported a patient alive and without relapse after four and



FIG. 12 (314451) —Diffuse carcinoma of the gall-bladder

one-half years, Worner, after three years, Kortze, after two years and two months, Mayo-Robson, after two years, Friedham, after three years, but dead after four years, Hochenegg, dead after three years and Patel, dead after two and one-half years. Quenu gives the immediate mortality as being due to hemorrhage, syncope, septicæmia, peritonitis, and shock.

From January, 1907, to January, 1921, 7878 operations were performed for gall-stones at the Mayo Clinic. Within this period primary malignancy of the gall-bladder (confirmed by pathologic examination) occurred in eighty-four cases (carcinoma eighty-two cases, epithelioma one, and lymphosarcoma

one) The carcinomas were divided into the adenomatous and the colloid types, the adenomatous type being much more frequent and taking the form of papillary or ulcerative growths, with a general thickening of the walls. Thirty-four gall-bladder specimens were available. In twenty-three the condition was a diffuse form of carcinoma with a general thickening of the walls of the gall-bladder. The fundus was no more frequently involved than the pelvis. In four the cancer was of the fundus, in three the condition was the flat ulcerative type, and one was of the papillary type. There was one papilloma of the middle portion, one of the pelvis, and three flat ulcerative



FIG 13 (314451) —Carcinoma shown in Figure 12 $\times 50$

growths at the neck of the organ. The epithelioma was situated at the fundus, the lymphosarcoma involved both the fundus and the pelvis.

In the series of eighty-four cases there were thirty-eight cholecystectomies and forty-six explorations. Stones were found in thirty-seven of the thirty-eight cholecystectomies. Stones were definitely present in thirty-three cases in which explorations were performed, they were undetermined in twelve and absent in one. The epithelioma was unaccompanied by stones, while the lymphosarcoma was associated with them. In a number of instances the growth was situated so that there could be no interference with bile drainage, thus probably disproving in these cases the hypothesis that the neoplastic obstruction produced the stones.

MALIGNANT NEOPLASIA IN THE GALL-BLADDER

In only nine cases was there a history of hereditary or family cancer. Sixty-eight of the patients were females, sixteen were males. The ages were as follows:

Years	Patients
1 - 10	0
11 - 20	0
21 - 30	2
31 - 40	2
41 - 50	12
51 - 60	37
61 - 70	27
71 - 80	3

SYMPTOMATOLOGY

The average duration of symptoms was from ten to thirty years, the longest duration was more than forty years. One patient had felt perfectly well until one month before operation, an inoperable carcinoma was found.

The average loss of weight was fifteen pounds. One patient had lost fifty pounds, another had gained in weight.

Sixty patients gave a definite history of gall-stone colic. Thirty-two complained of a dull pain either with or without colic. The pain was situated in the epigastrium in forty-three cases, in the right hypochondrium in forty-four, in the upper left abdomen in six, and in the lower abdomen, back or precordial region each in one. The pain radiated to the back in thirty-eight cases, to the right shoulder in eleven, to the left shoulder in four, and to the right iliac fossa in two. Eusterman has called attention to the frequency of pain in the back in cases of malignancy of the gall-bladder. Thirty patients had pain so severe as to require morphia for relief. One patient was given chloroform.

Forty patients had varying degrees of jaundice. Forty-seven had vomited and fifty had been nauseated, forty-three had been constipated, and one had had diarrhoea.

Twenty-three patients gave a history of fever.

Forty-nine patients complained of tenderness on palpation, in forty the tenderness was in the right hypochondrium, in nine in the epigastrium. A mass was palpated in thirty-seven, in thirty-two in the right upper abdomen, in three in the epigastrium, in one in the middle abdomen, and in one in the lower abdomen. The liver was definitely palpable in seven patients, one only had physical signs of ascites.

Test meals were given to thirty-three patients and achlorhydria was found in one, subacidity in nineteen, normal acidity in twelve, and hyperacidity in one.



FIG 14 (314451) —Carcinoma shown in Figure 12 x500



FIG 15 (27259) — Innocent gall stones

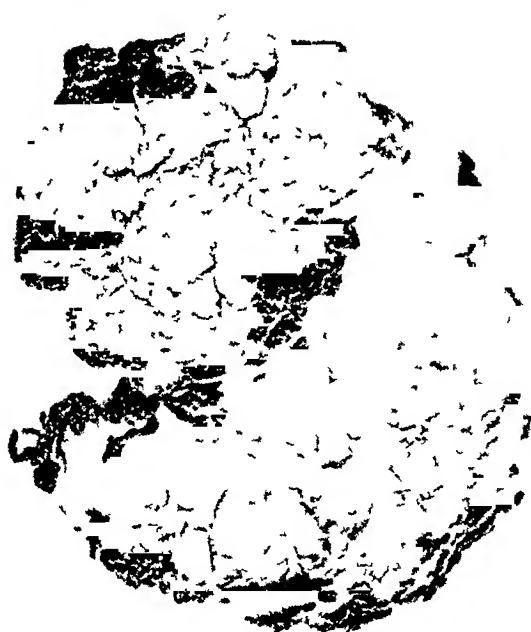


FIG 16 (163101) —Epithelioma of the gall-bladder



FIG 17 (163101) —Epithelioma shown in Figure 16 $\times 50$

DIAGNOSIS

It is extremely difficult to diagnose malignant conditions of the gall-bladder early enough to obtain favorable results from surgical treatment. Usually the chief symptoms are those of gall-stones, and there does not seem to be any additional chain of symptoms whereby the onset of malignancy can be foretold. Rapid loss of weight and strength, pain referred to the back, and a mass with or without jaundice, indicate advanced malignancy in some cases. Malignancy in the bile ducts or in the pancreas can scarcely be differentiated. Severe cholangitis with or without stones in which there is

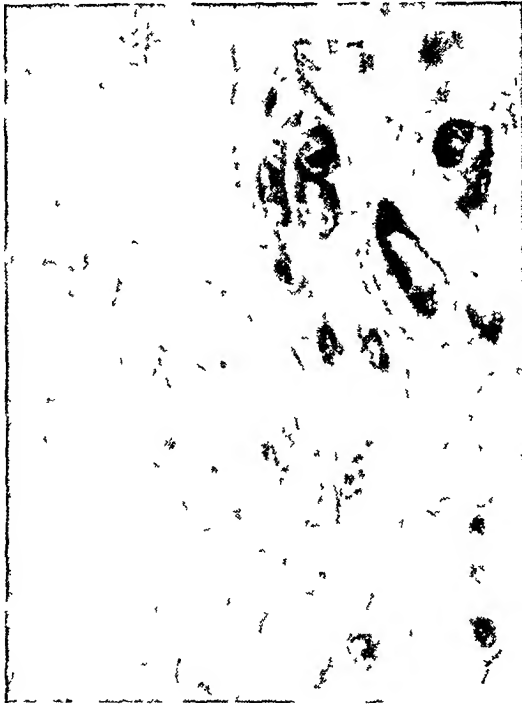


FIG 18 (163101) —Epithelioma shown in Figure 16 $\times 1000$

a rapid loss of weight may be confused with neoplasia. Empyema of the gall-bladder may simulate malignancy.

In the thirty-eight cases of cholecystectomy a diagnosis of gall-bladder disease with or without stones was made in twenty-five, in five a questionable diagnosis of cancer of the gall-bladder was mentioned, while in one, cancer of the liver was diagnosed.

In the forty-six explorations, gall-bladder disease was diagnosed in twenty-two cases, malignancy of the gall-bladder in twelve, and of the liver in three.

TYPE OF OPERATION

Cholecystectomies were performed in thirty-eight of the eighty-four cases. In six of these a portion of the liver was also removed, and in one three-fourths of the common duct was resected. Choledochotomy was performed

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in five In forty-six cases the condition was considered inoperable from a radical point of view A partial cholecystectomy was performed in four, cholecystostomy in ten, and choledochotomy, appendectomy and posterior gastro-enterostomy each in one case In the cases in which the gall-bladders were removed the growth had extended to the liver in nine, to the biliary ducts in four, to the pancreas in three, and to the lymph-glands in five Explorations showed that the growths had extended to the liver in thirty-seven, to the bile ducts in two, to the lymph-glands in thirteen, to the pancreas in three, to the stomach in three, to the colon in four, to the duodenum in two, to the small intestine in four, to the operative incision in one, to the peritoneum in three, to the omentum in two, to the pleura in one (necropsy), to the left lung in one (necropsy), and to the pelvis in one

PROGNOSIS

The operative mortality in the series reported was not exceedingly large One patient died within the two weeks following cholecystectomy Seven died within the two weeks following exploration, a total of eight of eighty-four patients

TABLE I
RESULTS OF OPERATION

Duration of Life	EXPLORATION	Patients	Duration of Life Years	CHOLECYSTECTOMY	Patients
1 week		5	1		1 *
2 weeks		2	2		5
				(Three still alive)	
3 weeks		1	3		1
1 to 2 months		9	4		1
2 to 3 months		6	5		0
3 to 4 months		2	6		1
4 to 5 months		2	7		1
			8		2
5 to 6 months		4		(One still alive)	
			9		1
7 to 8 months		2		(Still alive)	
8 to 9 months		0	10		1
			11		1
9 to 10 months		1		(Still alive)	
10 to 11 months		1	12		0
Alive 11 to 12 months		2			
Alive 2 years after operation		1	Months		
Alive 1 year after operation		1	1		3
			2		1
			3		0
			4		3
			5		0
			6		2
			7		2
					—
					26

Seven patients could not be traced

Twelve patients could not be traced

* Patient alive one year after operation, not heard from since

The cases are divided into three groups

Group 1—Cases in which after symptoms of gall-stone colic for years there is a sudden change, the patient begins rapidly to lose weight and strength, the pain becomes continuous, jaundice, fever, and a tumor may or may not be present

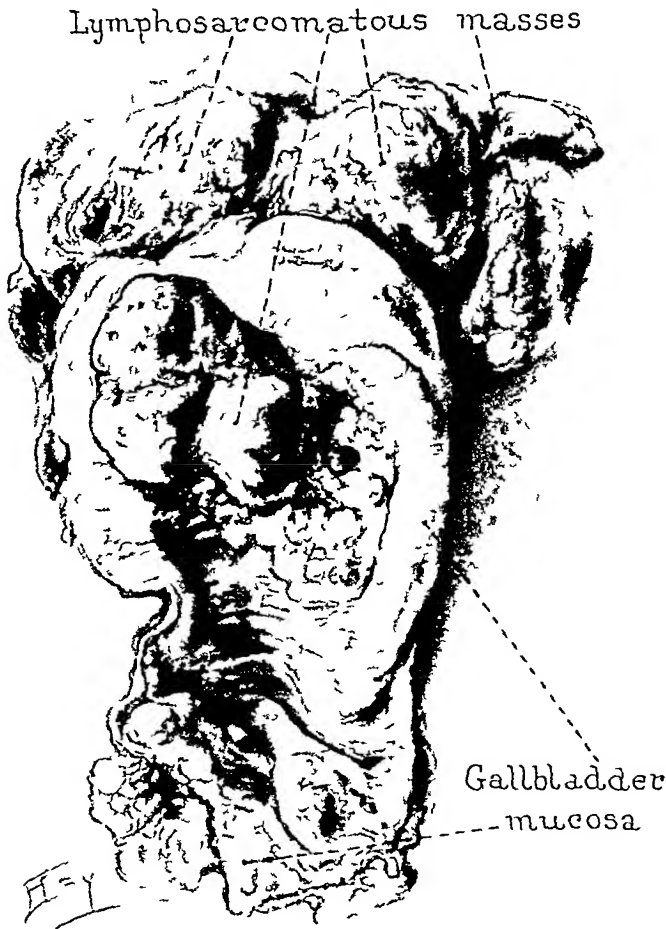


FIG 19 (342964) —Lymphosarcoma of the gall bladder with adjacent liver tissue

Group 2—Cases similar to those in Group 1 with the exception that instead of symptoms of gall-stone colic there are symptoms of gall-bladder dyspepsia

Group 3—Cases in which there are no symptoms up to one year before operation, then a sudden development of symptoms of malignancy, rapid loss of weight and strength, cachexia, and tumor. Jaundice may or may not be present. Some of these patients may have pain, either of a dull boring character, or that of gall-stone, others may not have pain

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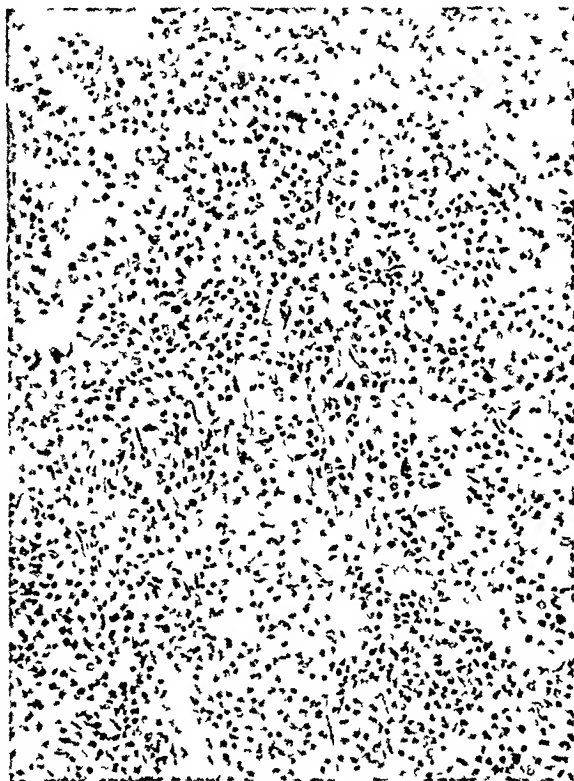


FIG 20 (342964) —Lymphosarcoma shown in Figure 19 $\times 50$

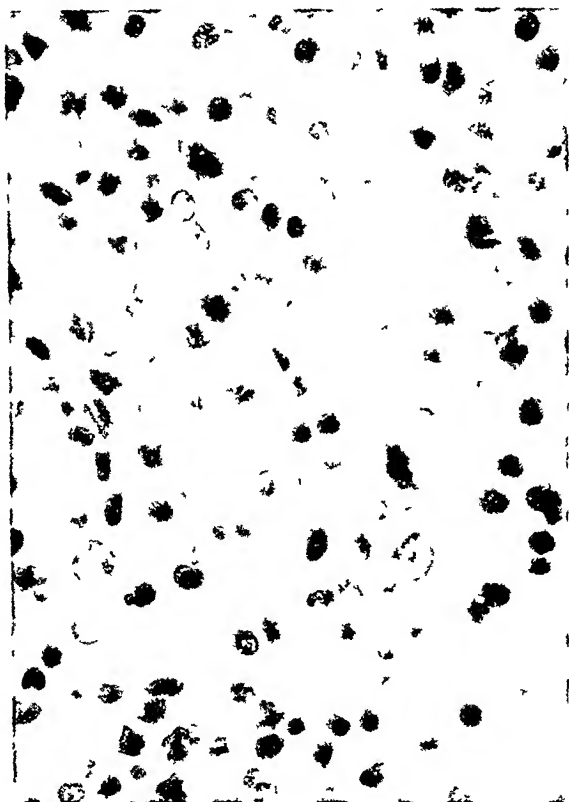


FIG 21 (342964) —Lymphosarcoma shown in Figure 19 $\times 500$

The forty-six cases in which exploratory operations were performed are divided into three groups thirty cases in Group 1, five cases in Group 2, and eleven cases in Group 3

DISCUSSION

Twenty-nine of the thirty-eight patients on whom cholecystectomies were performed had had symptoms referable to the gall-bladder for more than one year, nine had had symptoms for less than one year

If the condition is operable cholecystectomy should be performed, cholecystostomy should only be performed when besides the tumor there is a severe infection of the gall-bladder, or as a path for the introduction of radium (W J Mayo)²⁸ Cholecystostomy for stones had been performed elsewhere in five of the eighty-four cases, indicating that malignancy may develop in gall-bladders that have been drained

W J Mayo²⁶ considers jaundice a contraindication to operation when a definite diagnosis of malignancy of the gall-bladder has been made

Complications may be due to perforation of the gall-bladder, as happened in one case in the series, to empyema, or to extension to the neighboring viscus by continuity, contiguity, or metastasis

Seven patients on whom a cholecystectomy had been performed were alive six years after operation, a percentage of 83 cures The diagnoses in these cases were gall-stones in three, gall-bladder disease in three, and gastric carcinoma in one (in this case adhesions had developed between the gall-bladder and the pylorus) The operative procedures were cholecystectomy in five, cholecystectomy, excision of adjacent liver tissue, and choledochotomy in one, cholecystectomy and gastroenterostomy in one (besides the malignancy there were gastric and duodenal ulcers)

CONCLUSIONS

- 1 Malignancy of the gall-bladder is not an uncommon occurrence
- 2 Carcinoma is the most common type of neoplasia found, sarcoma is exceedingly rare
- 3 Gall-stones are complications in a very large number of cases
- 4 Heredity seems to have little influence in the development of malignancy in this organ
- 5 Females and males are afflicted in the ratio of about four to one
- 6 Seventy-five per cent of cases occur between the ages of fifty and seventy
- 7 In most cases there has been a history of gall-stones for some time
- 8 Early cholecystectomy for stones will either prevent the development of malignancy or find the condition in its incipency
- 9 Late operation is of little value except as a diagnostic procedure

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PERFORATING GASTRIC AND DUODENAL ULCER*

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PERFORATING ulcer of the stomach or duodenum is not common, yet it is a sufficiently frequent and serious calamity to merit the most respectful consideration. From a survey of the cases which have occurred in the surgical clinic at the University Hospital, surgery has not proven as efficacious as could be desired. The lesson gleaned from a careful study of these cases is, that surgery has failed to meet its obligation, in that there has been less than 50 per cent. of cures. It is begging the question and shunting responsibility to excuse surgery for these poor figures by replying there would have been 100 per cent failures if medical treatment alone were used. Apparently after rupture, no matter how quickly these cases come under the knife, somewhere around one-half will perish. This is a fearful mortality. Despite proper drainage and early operation and the Fowler position, as far as this clinic is concerned one out of every two cases is doomed. Apparently, therefore, improvement in the mortality rate is not to be sought so much in operating early after perforation, but in interference before rupture. As soon as perforation occurs the patient is gravely ill, previous to this catastrophe he is sick, but in most instances a good surgical hazard. Consequently after a diagnosis of a chronic ulcer of the stomach or duodenum temporizing measures are inexcusable, as chronic ulcer of these structures from the onset is a surgical condition and amenable alone to surgery. Like appendicitis, one is never assured that ulcer of the stomach or duodenum is cured. The patient might go along for a long period in comparatively good health and then, like a flash of lightning out of a clear sky, he will be struck down with agonizing pain, located principally in the epigastrium. The suddenness of the onset, the intensity of the pain and the board-like rigidity of the overlying muscles, together with a history of previous gastric disturbances, especially hunger pains coming on one, two, three hours after eating which are relieved by ingesting more food, make the diagnosis. It should be borne in mind, however, that in some of these cases the patient never has any symptoms referable to the digestive organs, and is struck down suddenly. These instances are fortunately very rare. The case histories presented below are not adduced as brilliant examples of surgical successes, but for the purpose of urging operation before rupture when the procedure is not overly dangerous to the patient's chance for recovery.

Of the 29 cases 14 recovered, 48.3 per cent, 15 died, 51.7 per cent, 27 were men, 2 women, 27 were white, 2 colored. Both of the colored patients were men. Their ages were 50, 60, 38, 50, 59, 23, 58, 29, 23, 21, 47, 35, 43,

* From the surgical clinic of the University Hospital, Baltimore

55, 34, 30, 32, 36, 29, 53, 37, 54, 65, 22, 53, 44, 58, 39, 29 years, respectively
These were divided into decades as follows

20-30	30-40	40-50	50-60	60-70
7	8	3	9	2

The youngest was 21, the eldest 65 years of age

The occupations were waiter 1, stevedore 1, housewife 1, druggist 1, patternmaker 1, seamen 2, laborers 5, shoemaker 1, stationary engineer fireman 1, painter 1, engineer 1, machinists 1, carpenter 1, foreman 1, farmers 3, not given 7 Sixteen were of the gastric type, 13 duodenal

The following operations were done Enterorrhaphy, 9, gastrorrhaphy, 7, posterior gastroenterostomy, 1, gastrorrhaphy and posterior gastroenterostomy with Murphy button, 1, gastrorrhaphy and posterior gastroenterostomy, 5, exploratory laparotomy and drainage, 1, pylorectomy and posterior gastroenterostomy, 1, exploratory laparotomy, died on table, 1, enterorrhaphy and posterior gastroenterostomy, 2, enterorrhaphy and appendectomy, 1

In all of these cases, number 25 excepted, drainage was made use of in some form In most of them the pelvic basin was also drained

As far as recovery was concerned it did not seem to make any material difference what type of operation was chosen

The causes of death were septicæmia, generalized peritonitis, toxæmia, subphrenic abscess and pneumonia

In all of the cases with the exception of No 28 the ulcer was situated in close proximity to the pylorus In the latter the rent was in the anterior wall of the stomach close by the cardiac orifice In reporting a series of cases it is usually the custom for one to put his best foot forward and record those instances only in which he has been succesesful This is the wrong attitude to assume, as equally as valuable information may be obtained from fatal as successful issues The above series is not a brilliant example of operative cures If the operators had been looking for a record the fatality list could have been somewhat reduced by refusing to operate on a few of these cases, as they were in very poor shape when they came to the operating table The chief lesson to be gained by a close perusal of the histories of these cases is that no matter how early they come to the operating table after rupture, there will be a mortality approaching 40 per cent Of the above series fourteen cases were received in the clinic within twelve hours after the rupture, of whom six died, 42.8 per cent This being true the question naturally arises, can't something be done to prevent this terrible mortality? To a very large extent the deaths were of men and women in the full bloom of life It represents a huge economic loss to the City, State and Nation It is agreed that the sooner the victim of perforation of the upper digestive tract is received the better his chance of recovery If, however, the mortality is somewhere around the figures enumerated, then surgery after rupture is somewhat lacking in its obligations, and relief must be sought elsewhere It is begging the question to say that 100 per cent of deaths would have occurred if medical means had been employed

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Of the twenty-nine cases twenty-three gave histories of stomach disturbances extending over a period of a few weeks to many years. In most of these the history was typical of ulcer. In fact, a few had even been diagnosed as ulcer. Leaving out of the question that carcinoma of the stomach is supposed to be preceded in at least 60 per cent. of the cases by ulcer and the other debilitating disorders incident to ulcer, the fact alone that 50 per cent. of the cases of perforating ulcer of the stomach or duodenum are doomed, should arouse the profession to the seriousness of this complication. Both the profession and the public have been educated to the importance of having a diseased appendix removed before it ruptures. In the first instance the procedure is a comparatively safe undertaking, in the latter the outcome is not so assured. Ulcer of the stomach or duodenum may be symptomatically benefited by medicinal agents but there is no assurance that it is ever cured. Here as in appendicitis a comparatively safe operative procedure may be instituted for a problematical namely a gastroenterostomy or a pylorotomy with a gastroenterostomy. If perforating ulcer is to be avoided and life preserved the profession must bring the ulcer case to operation before rather than after rupture. I am fully aware that the responsibility resting upon the internist is great in recommending operation in conditions of the upper abdomen but if a worse catastrophe is to be avoided, the victims of chronic indigestion and of hunger pains relieved only by further eating must be brought to the surgeon earlier. This is the lesson that this series teaches. *Discite moniti*

CASE REPORTS

CASE I—J. P., white, male, aged fifty, was admitted to the University Hospital on December 1, 1908, with the history of having been ill for three weeks. The trouble began with acute abdominal pain located for the most part in the epigastrium. After a few days this pain subsided somewhat, but he continued to run fever, his pulse continued to be accelerated and the abdomen remained distended. When brought to the hospital he gave the appearance of being very septic, his pulse was very rapid and thready, temperature irregular. His abdomen was noticeably distended and rigid throughout. Meteorism was extreme. He was immediately placed in the upright position and proctoclysis administered and his abdomen packed with ice. The meteorism was gradually relieved by numerous enemata. A diagnosis of generalized peritonitis, probably the result of a ruptured appendix, was made.

Two days after admission a low right rectus incision was made and upon opening the peritoneal cavity a large quantity of thick pus containing numerous flakes of fibrin was evacuated. The appendix when delivered was but slightly inflamed and was not the cause of the peritonitis. Consequently a hand was introduced into the upper abdomen and released a large collection of pus. The incision, therefore, was extended upwards to enable a better inspection of the upper digestive tract. This manoeuvre demonstrated a perforated duodenal ulcer. After separating the duodenum from the liver, to which it was adherent the hole in the bowel was sutured. Further search revealed another abscess which was also evacuated. This abscess had for its wall the duodenum the liver and omentum. At this stage of the operation the patient's condition was so critical that drainage tubes were hurriedly placed in the pelvis subhepatic space and through a counter-

opening in the right loin, the wound closed down to the drains and the patient gotten off the table. After being put to bed the man gradually recovered from his shock, but for some days his course was very stormy and his convalescence was complicated by a bilateral pleurisy. However, he finally fought down his peritonitis and pleurisy and was discharged from the hospital on January 21, 1909, cured.

CASE II—This patient, a white man who could speak but little English, was admitted to the hospital January 2, 1909, with the complaint of severe pain in the upper abdomen. He was about sixty years of age. Examination revealed an abdomen, concave in its upper portion, convex in its lower. The abdominal wall was very rigid and tender, but most sensitive in its upper right quadrant. There was no history of vomiting. The rectum was distended, but nothing abnormal could be palpated. Operation was advised, but refused until the next morning, January 3rd, when he accepted. By this time, however, his condition was almost hopeless.

Operation January 3, 1909, ether anæsthesia, iodine technic, gastrorrhaphy, died. The abdomen was opened by a midline incision. On reaching the peritoneum a quantity of gastric contents was found lying free in the peritoneal cavity. After mopping this up, further search developed a ruptured ulcer in the anterior wall of the stomach, situated in close proximity to the pylorus. This was closed. The man's condition did not warrant further interference, so free drainage of the peritoneal cavity was hastily applied, the wound closed as far as practical and the patient returned to his bed. He was by this time in a moribund condition, failed to rally, and died several hours thereafter.

CASE III—H. M., male, colored, aged thirty-eight years, waiter, married, was admitted to the hospital slightly after midnight, January 9, 1909, with the complaint of intense abdominal pain, which began about one hour before admittance. The patient had had very little illness previous to a year ago, to which his present illness dates. He had been a waiter for the past eight years. His meals were eaten at very irregular intervals, and he would often munch food between meals. Very often he would taste soups and liquids of various kinds when they were hot. About a year ago he began to suffer with pain and fullness about the stomach. He was treated some time for indigestion, but was not relieved. He lost about thirty pounds in weight during the last six months of his sickness. The pain was most severe about one hour after eating. At times it would cause him to stop work and sit down. About an hour previous to admission he was sitting down to eat, when he was seized with a violent pain in the upper abdomen, just about the median line, one and a half inches below the ensiform cartilage. He was brought to the hospital in an ambulance and placed in bed. Examination showed the following. The abdomen was very rigid, so much so one could not palpate deeply at all. It was concave from the xiphoid cartilage to the umbilicus, and convex from this point to the pubes. It was tender over the entire right side, more so over the gall-bladder region. The pain was severe and constant. The temperature by mouth was $97\frac{1}{2}$ degrees F, by rectum $99\frac{3}{4}$, pulse 90, respiration 24. His expression was quite anxious, the tongue dry but clean. When an operation was mentioned to the patient he expressed himself as not caring what was done, so he was relieved. Nothing could be palpated in the pelvis by rectal examination. The man's bowels had not moved for twenty-four hours. An ice-bag was placed over the gall-bladder region and one ounce of magnesium sulphate was administered, also morphia and the patient made ready for operation. Seven hours later his bowels had not moved. He had not vomited. An enema was given which was not effectual. A second was administered with the tube inserted well up into the rectum. This likewise did not prove effectual and the fluid had to be siphoned off.

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Operation, January 9, 1909, ether anæsthesia, iodine technic, gastrorrhaphy and posterior gastroenterostomy by Murphy button, recovered. The abdomen was opened through a midline incision extending from the ensiform cartilage to the umbilicus. As soon as the peritoneum was opened, gastric contents were found free in the peritoneal cavity. After sponging out the escaped material, the stomach was exposed and a perforated ulcer found in the anterior wall of the pylorus. The opening was about the size of a dime. There was a mass of adhesions around the gall-bladder which was itself tied down to the pyloric end of the stomach. These were broken up, thus releasing the gall-bladder from the stomach. The ulcer was closed with fine silk sutures and a posterior gastroenterostomy was made by means of a Murphy button. The patient's abdomen was drained with rubber tissue tucks, one being placed in the lesser peritoneal cavity. The incision was closed down to the drains and the patient sent back to bed. Nothing was permitted by mouth for forty-eight hours, during this period fluid was administered by means of normal salt enemata. Convalescence was smooth and uneventful and the patient was discharged from the hospital four weeks after entrance, cured.

CASE IV—J S, white, male, aged fifty, stevedore, entered the hospital July 31, 1909, with the complaint of pain in the abdomen. About two hours before coming to the hospital, the patient was seized with violent pain in the abdomen, which gradually grew worse. The stomach symptoms date back two years, during which period he had intermittent pain in his stomach and indigestion for which he received treatment under the diagnosis of gastritis. The pain was more marked about one hour after meals. The distress did not cease, but continued to grow worse until July 31, 1909, on which date he was brought to the hospital. The patient had never vomited and until now he had never had any alarming symptoms. Five hours previously he was seized with a severe pain in the abdomen. It was most pronounced in the upper right quadrant. There were no clinical findings other than marked muscular rigidity and tenderness over the entire abdomen, with the point of maximum intensity in the upper abdomen. The pain was very sharp and lancinating. His mouth was dry and tongue coated. There was no tympanites, yet there was some little distention in the lower abdomen, which was concave above and convex below. Rectal examination bore no results. The leucocyte count was 13,500, the temperature 99 $\frac{1}{2}$ degrees F, pulse 105, respiration 50.

Operation, July 31, 1909, ether anæsthesia, iodine technic, gastrorrhaphy and posterior gastroenterostomy, recovered. The abdominal incision was made to the right of the midline and extending two inches above and below the umbilicus. Upon opening the peritoneum, gastric contents were found lying free between the coils of the gut. The extravasated material was mopped up. Search for the source of the leakage revealed a perforated ulcer in the anterior wall of the pylorus. This was closed with a purse-string suture and a posterior gastroenterostomy made. The upper abdomen was drained as well as the pelvis through a stab wound above the pubes. The patient was then returned to bed and placed in an upright position. He was not allowed anything by mouth for forty-eight hours, after which he was permitted ice and one ounce of water every two hours. The next day he was given liquids and two days thereafter was placed on soft diet. For the first twenty-four hours drainage was profuse, after which there was very little discharge. The temperature after operation never exceeded 101 degrees F, and the pulse 105. The respirations came down to normal soon after the operation. The man was discharged August 15, 1909, cured.

CASE V—M E M, white, female, aged fifty-nine, married, housewife, of Baltimore, was admitted to the hospital June 18, 1912. She had been suffering with vague stomach symptoms for four days, for which she had taken bismuth,

ordered by her family physician. She was suddenly taken worse and in the emergency called in Dr W H Smith. At the time he first saw her she was suffering agonizing pain in the upper abdomen which had come on suddenly and was so severe as to evoke cries. The pain was peculiar, coming on in paroxysms, the intensity abating and increasing alternately. At this time there was little rectus rigidity or distention of the abdomen, but constipation was marked. As the patient was extremely sick she was ordered removed to the hospital where she arrived about 8 P M. At that time her pulse was slow and nausea was present. As soon as she could be put to bed and made comfortable, a hydrogen peroxide enema was administered. This proved effectual and she became more comfortable. The improvement lasted until 4 A M, when the pain in the abdomen recurred. At that time the pulse was 60, respiration 18, temperature 97³/₁₀ degrees F. There was some abdominal rigidity and tenderness, but not so great as one would suppose for so severe a catastrophe. The indications for laparotomy were plain.

Operation, June 10, 1912, ether anæsthesia, iodine technic, gastrorrhaphy, died. A high right rectus incision was made. Upon entering the peritoneal cavity stomach contents were found, directing attention immediately to the character of the lesion which previously had been suspected. The source of the leakage was a small hole on the anterior aspect of the stomach near the pylorus. The opening was sutured and four drains inserted, two cigarette and two rubber tubes. The wound was closed to the drains. The next day, June 20th, the dressing was removed, but little drainage had occurred. On June 21st, the temperature began to rise until it reached 102⁴/₁₀ degrees F, when the patient died. There was no apparent reason for the unfortunate outcome. At operation there was a generalized peritonitis, but as the woman was placed in the upright position, a favorable outcome was anticipated, especially as a rubber tube and a cigarette wick had been placed in the pelvis.

CASE VI—F F W, white, male, aged twenty-three years, druggist, entered the hospital, January 8, 1914, with the complaint of pain in the stomach. The pain began about 8 P M, a short while after eating a hearty supper. It was sudden in onset, cramplike, and situated about the middle of the abdomen. The hurt was so severe as to compel the patient to go to bed, but his condition becoming so alarming he was brought soon thereafter to the hospital. Up to December, 1913, the past history was negative. About that time he had an attack of pain in the epigastrium which came on about two hours after eating dinner. This discomfort and pain was relieved by eating a light supper. The next day he had a similar attack, but that one did not last so long. Following those attacks at intervals the patient had some accumulation of gas and eructation. Five days after the first attack the patient was taken suddenly at midnight with severe pains around the umbilicus and epigastrium. That attack lasted all night, but after eating breakfast he felt better. He had no further trouble until the day of admission. The general examination revealed nothing abnormal, except a markedly anxious face. The abdomen was very rigid and exquisitely tender, especially in the right side. There was no tympanitis. The pulse was 100, the mouth temperature 97 degrees F, rectal 100. Immediate operation was advised and accepted.

Operation, January 8, 1914, ether anæsthesia, iodine technic, enterorrhaphy, recovered. An upper right rectus incision was made. Upon entering the peritoneum a large quantity of turbid fluid was found in the abdominal cavity and the evidences of a more or less widespread generalized peritonitis. The appendix was located and found to be normal. A search in the upper abdomen discovered the source of the trouble to be a perforated duodenal ulcer near the pylorus. The opening was closed with a purse-string suture and the line of suturing reinforced with an omental graft. Drainage of the pelvic basin was obtained by

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a counter-incision above the symphysis. The original incision was closed down to the drains which had been placed in the upper abdomen. The patient was returned to his room in good condition. The convalescence was uninterrupted and the man was discharged February 12, 1914, cured.

CASE VII—J G, white, male, aged fifty-eight, came to the hospital September 18, 1914, with the complaint of a lump and pain in the abdomen. About two weeks previous to admission the patient was taken with a rather acute pain in the abdomen. This was severe and cramplike. He had been working up to that time, but with the onset of the trouble he was forced to quit work because of pain and weakness. He had had some fever, also nausea, but did not vomit. He stated that for a number of years he had been annoyed with stomach trouble, such as pain, pyrosis, and bad digestion. During the last year of his sickness he lost fifteen pounds in weight. On admission the pain in the abdomen was not so severe, but he was considerably bothered with flatulency. When the gas was expelled he experienced much relief. Several days after the onset of the trouble the patient noticed a lump in the left side just below the costal margin. By the time he had come in the hospital it had increased somewhat in size and was rather tender to the touch. He had an anxious expression, was very emaciated and his abdomen was slightly distended. The abdominal muscles were quite rigid. The entire abdomen was tender, so much so that a satisfactory examination was impossible. He complained of some intraabdominal pain, located principally in the upper quadrants. On the left side about two inches below the costal margin could be felt a nodular tumor about the size of a clenched fist. It was very tender to the touch and gave the impression of being fixed to the abdominal wall and underlying structures. By careful palpation it was thought that fluctuation could be detected. The pelvis was investigated by a finger introduced into the rectum. It seemed to be filled up with a soft tender mass.

Operation, September 24, 1914, ether anæsthesia, iodine technic, exploratory laparotomy, drainage, died.

The patient when taken to the operating room was in bad condition and a hurried operation was in order, so the abdomen was entered through a left rectus incision centering on the umbilicus. On opening the peritoneum there escaped a quantity of foul-smelling pus. By now the man was in such poor condition that it was deemed inadvisable to make a further search for the lesion at the base of the trouble, so a liberal supply of drainage tubes were placed in the pelvis and the upper abdomen and after placing a few sutures in the superficial tissues the patient returned to the ward. He failed to rally, however, and died at 2 A M, September 29, 1914, of toxæmia and generalized peritonitis, complicating a perforated gastric ulcer, as determined by partial autopsy.

CASE VIII—C G, white, male, aged twenty-nine, patternmaker, entered the hospital, October 27, 1914, at 3 P M, with the complaint of pain in the stomach. With the exception of several mild attacks of indigestion within the past two years, his past history was of no especial interest. These attacks gave very little trouble and no attention was paid to them. His last attack began October 27, 1914. About 11 A M, while he was at work, he was taken suddenly with such violent and severe pain in the abdomen that he was compelled to quit work. He went home and called in a physician. All the while the pain persisted. He was nauseated and vomited once. Showing no signs of improving, the physician brought him to the hospital. On admission the patient still had pain, but it had subsided somewhat from the administration of a hypodermic of morphia. Examination revealed very tense recti muscles and tenderness over the entire abdomen, but these symptoms were most pronounced in the upper abdomen. The mouth temperature was 100 degrees F, pulse 105. Immediate operation was advised and accepted.

Operation, October 27, 1914, ether anæsthesia, iodine technic, gastrorrhaphy and posterior gastroenterostomy, recovered The abdominal cavity was entered through an upper right rectus incision Upon opening the peritoneum, a large quantity of yellowish-white fluid escaped which gave rise to the suspicion of a perforated gastric ulcer as the cause of the gastric crisis On delivering the stomach a small ulcer which had perforated was found in the anterior wall of the stomach close to the pylorus This was closed with a purse-string suture of silk and the suture line covered with a piece of omentum As this procedure caused a constriction of the pylorus, a posterior gastroenterostomy was done A small incision was made through the abdominal wall just above the pubes through which tube drainage was inserted into the pelvis The first incision was then closed and the patient returned to his bed in good condition The convalescence was smooth, uneventful, and uninterrupted, and the man was discharged November 19, 1914, as cured He was eating ordinary food with the greatest relish and the wounds were entirely healed

CASE IX—This patient was a young white man, aged twenty-three years He was brought to the hospital by his physician and gave the history of having been seized suddenly on October 28, 1914, with a boring pain in the upper part of the abdomen On examination the abdomen was tense, rigid and very tender in the upper part His pain was intense and his physician stated that he had given repeated doses of morphia which was pushed to tolerance, yet the pain persisted On admission the patient's temperature was 99 $\frac{3}{4}$, pulse 95, and respiration 20 The leucocyte count was 15,600 He gave a history of having suffered from repeated attacks of indigestion, with pain, gas, sour stomach and belching He stated he had suffered thus for some years, exactly how long he could not say He had continued to grow worse until the crisis came

Impression—Perforated gastric ulcer

Operation, October 28, 1914, ether anæsthesia, iodine technic, gastrorrhaphy and posterior gastroenterostomy, recovered The abdomen was opened by a right rectus incision extending from the costal margin to a point on the level with the umbilicus When the peritoneum was opened, it was discovered that a generalized peritonitis had already set in There was a quantity of bile-tinged serous fluid between the coils of the intestines The stomach was brought into view and a large perforated ulcer was detected at the pylorus An effort was made to close the hole with a suture but the tissue was so necrotic it would not hold A piece of omentum large enough to cover the hole was cut off with which the rent was sealed After closing the opening the posterior wall of the stomach was exposed and a gastroenterostomy made Free drainage both of the pelvis and the general abdominal cavity was provided, the wound closed to the drains and the patient returned to his bed in poor condition He remained unconscious and delirious in spells for four days, when he began to improve On November 14th, he was permitted the use of a wheel chair He was discharged November 24, 1914, his drain tract had closed, his appetite was good, his bowels regular, temperature and pulse normal He was pronounced cured

CASE X—P C V D, white, male, seaman, aged twenty-one, entered the hospital March 30, 1915, at 2 P M, with the complaint of pain in the stomach The trouble began while at work, the afternoon of the day before, with sudden, violent cramplike pains throughout the entire abdomen The pain was so severe that the patient was compelled to stop work and had to be carried to a cabin, at which time he was given castor oil The treatment did not give relief, so the day following upon arriving in port, he was transferred to the hospital At that time he was still complaining of pain, but it had somewhat ameliorated, nevertheless he appeared to be growing more ill For the past two years he had had intermittent attacks of abdominal pain and indigestion He was in a

hospital about six months ago, when a diagnosis of gastric ulcer was made. The man was markedly emaciated, the cheeks were flushed, the face bore an anxious expression and the pulse was rapid and feeble. Although there was no tympanites, the abdomen exhibited marked muscular rigidity and tenderness throughout its entire extent, especially was this true of the right side about the umbilical level. The mouth temperature was 100 degrees F, the rectal 102. A serious abdominal crisis was recognized and immediate operation advised and accepted.

Operation, April 3, 1915, ether anæsthesia, iodine technic, gastrorrhaphy, recovery. An incision was made over the right rectus muscle. Upon opening the peritoneum a great quantity of whitish, flaky fluid was found free in the abdominal cavity. The appendix was located and found to be normal. In traversing toward the stomach the intestines were found to be covered with fibrin, and upon delivering the stomach a perforated ulcer was found on its greater curvature situated about one and a half inches from the pylorus. This was closed with a purse-string suture of silk and the suture covered with a small piece of omentum. There did not appear to be any obstruction to the pyloric orifice, so a gastroenterostomy was not considered advisable. Rubber tube drains were placed in the pelvis, along with cigarette drains in other portions of the abdomen, and the wound closed about the drains. The patient made an uninterrupted recovery. The wound with the exception of the drainage tract healed by first intention, and the man was discharged on May 24, 1915, as cured, having gained weight, with normal digestion and eating regular food.

CASE XI—M P, white, female, married, aged forty-seven years, entered the hospital the evening of September 7, 1915, with the complaint of persisting vomiting. She said she would vomit food she had eaten three or four days previously, for which ailment she had been treated by several physicians who pronounced the trouble indigestion. She had lost weight constantly during the year immediately preceding her illness, but more rapidly the last two months. The abdomen was of the scaphoid type. No masses could be felt. There was only slight tenderness above the umbilicus. X-ray examination demonstrated a huge stomach and a complete arrest of food at the pylorus, no bismuth showing in the small intestine after twelve hours. Gastric analysis showed a low hydrochloric acid content, a large quantity of yeast cells and decomposition products. Impression. Complete pyloric obstruction, gastric ulcer.

Operation, September 9, 1915, nitrous oxid ether anæsthesia, iodine technic, pylorotomy and posterior gastroenterostomy, recovered. A right rectus incision was made extending from the costal margin to below the umbilicus. The pylorus was found to be very thick with an obliterated lumen. The gall-bladder was plastered to the posterior wall of the pylorus. This was separated, exposing an old ulcer which had perforated. The whole pyloric area was thick and hard, but no glands were palpable. After tying off the blood supply to the pyloric end of the stomach and that to the proximal end of the duodenum, the ulcer-bearing area was resected, the ends of the stumps cauterized and turned in by Lembert sutures. A posterior gastroenterostomy was then done, drainage instituted and the wound closed down to the drains. The patient was returned to her room in good condition. After operation she experienced no pain nor difficulty with her stomach. Her appetite was excellent and nothing seemed to disagree with her. She was discharged September 28, 1915. At that time her wound had ceased draining and was almost closed.

CASE XII—F D, white, male, thirty-five years of age, laborer, came to the hospital, November 22, 1915, with the complaint of pain in the lower abdomen. He stated he had had abdominal pain for two or three weeks. It was diffuse and was not very severe or prostrating. There was very little fever, but some nausea and vomiting. The pain gradually localized in the right iliac fossa. He gave no

history of any pain after eating, nor of gastro-intestinal disturbances of any standing. However, the man had been feeling badly for some time and complained of loss of appetite. Otherwise the history was of no interest. Other than a tender, tympanitic abdomen which was distended and painful, nothing abnormal could be found. The seat of maximum intensity of the pain was in the lower right abdomen. There was no fever or acceleration of pulse. The belly was quite hard, and muscle spasm rather noticeable in the right side. The white blood-cell count was 18,900.

Operation, November 23, 1915, ether anæsthesia, iodine technic, enterorrhaphy, cured. When the abdomen was opened through a right rectus incision, some free pus was seen between the coils of the intestines and a plastic exudate on their anterior surface. The appendix was delivered and found not sufficiently diseased to account for the severe peritonitis, so the incision was lengthened upwards. Now the stomach and duodenum were visible and were seen to be covered with a thick mass of omentum which was bound intimately to these structures, especially in the neighborhood of the pylorus. The omentum was divided and stripped from the surface of the gut, exposing about 2 cm. from the pylorus a perforated ulcer, from the opening of which gas and bile were escaping. The aperture was closed with a purse-string suture and a piece of omentum was stitched over the suture line. Drains were inserted in the neighborhood of the liver and in the pelvis. The soft tissues were closed down to the drains and the patient returned to his room in good condition. For the first few days after the operation there was a slight rise in temperature, pulse and respiration, otherwise the convalescence was smooth and the man was discharged January 1, 1916, with the wound completely closed. He was considered cured.

CASE XIII—G. H., white, male, shoemaker, aged forty-three, single, entered the hospital January 5, 1916, on account of pain in the abdomen. He stated that while at work the morning of the day of admission, he was suddenly taken with violent pain in the abdomen, which did not subside as the day wore on, but became progressively worse, necessitating him seeking the hospital for relief. After the onset of the trouble he was nauseated and vomited, but prior to the seizure was feeling perfectly well. His appearance was that of a very ill man. His face was anxious and pinched. Marked muscular rigidity was present throughout the entire abdomen, likewise tenderness, but more prominently in the upper right segment. The abdominal wall was so rigid that no tumor masses could be felt. The pulse was rapid and suggestive of a severe crisis. The mouth temperature was 97 degrees F, rectal 100. He denied ever having had lues or gonorrhœa. Suspecting a perforated gastric ulcer, operation was advised but declined. About three hours after admission the man's condition had become critical, operation was again suggested, and this time accepted.

Operation, January 6, 1916, ether anæsthesia, iodine technic, gastrorrhaphy, recovered. The abdominal cavity was reached through a right rectus incision centering on the umbilicus. Upon opening the peritoneum a large quantity of brownish, flaky material escaped which immediately drew attention to rupture in the upper alimentary tract. So a search was instituted for a hole in the stomach. This investigation was rewarded by the discovery of a rent about the size of a pea in the greater curvature of the stomach close to the pylorus. The hole was encircled by a purse-string of silk and closed. In order to further secure against the possibility of leakage a second row of suturing was made use of and a piece of the lesser omentum tacked over the suture line. Tube drainage was introduced into both the right renal and pelvic fossæ as well as to the site of injury and the wound closed down to the drains. The patient was returned to the ward in fair condition. From that time until March 11, 1916, when he was discharged, convalescence was uninterrupted.

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CASE XIV—E P C, white, male, aged fifty-five, stationary engine fireman, was admitted to the hospital January 17, 1917, with the complaint of severe intra-abdominal pain. He was exhausted and gave the following history. For some years he had been a sufferer from indigestion. He had had marked gastrointestinal disturbances with much discomfort in the upper abdomen. Early in the morning of the day of entrance the patient had a sharp attack of pain in the midline of the upper abdomen. The pain was prostrating and the man was extremely shocked from the onset of the attack. On admission he was in bad shape, expression listless, tongue dry, skin pallid, pulse poor, and he was bathed in a cold perspiration.

Operation, January 17, 1917, ether anaesthesia, iodine technic, exploratory laparotomy, died on the table. A midline incision was made through the upper abdomen. This permitted the escape of about 500 c.c. of a flaky, greenish pus. The viscera were extremely congested. During the exploration the man became more and more feeble and died on the table. Examination of the stomach showed a large, punched-out ulcer about the size of a half dollar, with a perforated base about the size of a quarter. The abdominal cavity was full of a purulent material.

CASE XV—J W, white, male, aged thirty-four years, painter, was admitted to the hospital February 25, 1917, with the complaint of acute abdominal pain. There was no history of previous gastric trouble. The attack was sudden in onset and from the beginning was so sharp as to double the patient up like a jack-knife. The illness began at 5:30 P.M., February 24th.

Operation, February 25, 1917, ether anaesthesia, iodine technic, enterorrhaphy, died. The abdomen was opened through the midline below the umbilicus and two cigarette drains and one rubber tube inserted into the pelvic basin. This wound was then closed with the exception of the aperture for the drains and another opening made through the right rectus below the costal border. Exposure of the duodenum revealed a small perforation just distal to the pylorus. This was closed with several interrupted silk sutures, the abdominal cavity washed out with hot salt solution and the wound closed with the exception of the tract left for drainage purposes, three cigarette drains to the site of rupture. The man was returned to bed badly shocked and died the same evening.

Autopsy. Duodenal ulcer, generalized peritonitis.

CASE XVI—A H, white, male, aged thirty, engineer, was admitted to the hospital April 20, 1917, with the complaint of severe pain in the abdomen which came on suddenly twenty-four hours previously while eating. It started first in the epigastrium, just to the right of the midline and gradually extended over the entire abdomen. During the three years preceding he had had stomach trouble, as manifested by pain about one hour after eating. This was relieved by bicarbonate of soda. Examination showed a considerably shocked man with a rapid, thready pulse and exquisitely tender abdomen, with boardlike hardness on palpation. The white cells were 36,000.

Operation, April 20, 1917, gas and ether anaesthesia, iodine technic, enterorrhaphy, died. On opening the peritoneum through a right rectus incision a quantity of gastric contents escaped. With much difficulty the opening was found on the anterior surface of the duodenum, about three inches from the pylorus. It was about an eighth of an inch in diameter. It was closed by Lembert sutures and reinforced by a second line of suturing. Drainage was obtained by three cigarette wicks and two tubes to the site of the perforation and two tubes and two cigarette tucks to the pelvic basin. The wound in the soft parts was closed down to the drains. The patient was returned to the ward badly shocked. He did well for a few days, after which he took a turn for the worse and steadily lost ground until death, April 26, 1917.

CASE XVII—L S, white, male, aged thirty-two, machinist, U S Navy, was admitted to the hospital November 23, 1917, with the complaint of pain in the upper abdomen. About five years previously he had had his appendix removed. Before and since that operation he had suffered with indigestion. On one occasion he had had a hemorrhage from the stomach for which he was kept in bed two months. On the morning of November 23, 1917, while walking in the street the patient was taken with a sudden and sharp pain in the epigastrium. The pain was so sharp the man could hardly get his breath. As time wore on there was no improvement, so the patient was brought to the hospital. On admission, a few hours after the onset of the illness, he was very pale, his expression was drawn and pinched, he was complaining bitterly of severe pain in the abdomen and begged for relief. His thighs were flexed on the abdomen and could not be straightened out. The entire abdomen was rigid and so tender the man resented the slightest touch. The rigidity and tenderness were most marked on the right side and in the epigastrium. The clinical impression was gastric or duodenal ulcer with perforation.

Operation, November 23, 1917, ether anæsthesia, iodine technic, enterorrhaphy and posterior gastroenterostomy, died. The patient was under operation within two hours after the onset of his attack, and under the circumstances should have been an excellent risk. A right rectus incision was made. On opening the peritoneum, a quantity of purulent material, mixed with small particles of what appeared to be undigested food, escaped. An ulcer about 2 cm in diameter was found to have perforated through the anterior surface of the duodenum about one inch below the pylorus. The opening was closed with mattress sutures of silk and a posterior gastroenterostomy made. Drainage of the pelvis was obtained by two rubber tubes, one through a stab wound above the pubes, another by way of the lower end of the incision. Four 'cigarette drains were introduced into the upper abdomen. The soft tissues were closed down to the drains. Twenty-four hours after the operation the patient developed a broncho-pneumonia in the left lung. His condition became gradually more critical and he died November 26, 1917, from œdema of the lungs. White blood-cell count, November 23, 1917, 26,000, white blood-cell count, November 26, 1917, 9000.

CASE XVIII—W F F, white, male, farmer, aged thirty-six, was admitted to the hospital February 12, 1918, with the complaint of severe abdominal pain. This was during the war period and the history is very meagre.

Operation, February 12, 1918, ether anæsthesia, iodine technic, enterorrhaphy, died. This man was operated upon at 10 30 P M, and returned to his room at 12 10 A M. He left the table in a very critical condition, did not rally, and died at 1 55 A M, February 13, 1918, of generalized peritonitis superinduced by a perforated duodenal ulcer which was sutured.

CASE XIX—M F, white, male, aged twenty-nine, laborer, came to the hospital May 5, 1918, with the following history. He stated about eleven o'clock last night he was taken suddenly with violent pain in the upper abdomen, especially around the umbilicus. He broke out in a profuse sweat and vomited some watery substance. He entered the hospital about fourteen hours after the onset of the attack. At that time he was very ill, and complained of intense pain in the abdomen, whose wall was very hard and board-like. He was tender over the entire abdomen, but this was accentuated over the upper right quadrant. He said he had suffered from indigestion all his life but had not been sick the day he was taken ill. The apices of both lungs were the seat of tubercular infection. The man was cachectic looking. A preoperative diagnosis of ruptured gastric or duodenal ulcer was made, and operation advised. The leucocyte count was 13,500.

Operation, May 5, 1918, gas and ether anæsthesia, iodine technic, enterorrhaphy, cured. A right rectus incision centering above McBurney's point was

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made When the peritoneum was opened the abdominal cavity was found filled with a turbid, flocculent fluid The intestines were red and in the upper abdomen covered with lymph There was considerable fluid between the liver and the diaphragm After much difficulty a small opening was found in the duodenum, located on its anterior surface and in close proximity to the pylorus This was closed with silk sutures, but owing to the friability of the intestinal wall the sutures cut out repeatedly With persistence the opening was closed securely A gastroenterostomy was not done The abdominal cavity was flushed with hot sterile water A rubber tube and three cigarette wicks were inserted above the stomach and between the stomach and liver A hand was then passed into the pelvis and a small incision was made above the pubes and one rubber tube and three gauze tucks introduced to the bottom of the pelvic pouch The upper wound was closed, save where the drains emerged On May 14, 1918, the wound began to discharge a yellowish fluid This was apparently from the duodenum With the exception of this setback the patient made a smooth and uninterrupted recovery and left the hospital August 4, 1918, with the drainage tract about closed and discharging no fluid

CASE XX—F S, white, male, carpenter, aged fifty-three, was admitted October 23, 1918, with the complaint of excruciating pain in the abdomen For years he had suffered with what he had supposed were attacks of indigestion He had had pains in the abdomen which came on several hours after eating Occasionally these pains were relieved by the ingestion of food or even water The present attack began about six o'clock in the evening, October 23rd, while the man was on his way from his place of work, Camp Meade, to Baltimore The abdomen was of a boardlike hardness and any attempt at palpation was bitterly resented by the patient He had not vomited The leucocyte count was 12,200, polymorphonuclears 70, lymphos 28, eosinophiles 2 per cent

Operation, October 23, 1918, ether anæsthesia, iodine technic, enterorrhaphy and posterior gastroenterostomy, recovered The abdomen was entered through a high right rectus incision Upon opening the peritoneum a large quantity of flaky material escaped Inspection of the pylorus showed a perforated ulcer in the anterior wall of the duodenum This was closed by mattress sutures and a posterior long loop gastroenterostomy done A stab wound was made in the lower abdomen through which a rubber tube and several cigarette drains were inserted into the pelvic basin A rubber tube and three cigarette tucks were placed through the upper wound to the neighborhood of the perforation, and the opening otherwise closed The patient was returned to his bed in fair condition The postoperative course was uneventful There was no rise in temperature and no gastrointestinal disturbances worthy of mention He was discharged November 18, 1918, cured

CASE XXI—J D S, white, male, foreman, aged thirty-seven, was admitted to the hospital November 16, 1918, through the accident room, with the complaint of severe pain in the belly He gave a typical ulcer history of several years' duration, periodicity of pain in the upper abdomen, relieved by the ingestion of food, the interval between attacks gradually becoming shorter until finally he was scarcely ever free from abdominal discomfort He stated the present attack began several days before he sought attention at the hospital The pain was very intense and but slightly influenced by opiates He was much shocked and in a desperate condition The abdomen was quite distended throughout and was very tender The recti muscles were extremely rigid The malady was diagnosed perforated gastric or duodenal ulcer and immediate operation advised

Operation, November 16, 1918, ether anæsthesia, iodine technic, enterorrhaphy, died A right rectus incision was made When the peritoneum was opened a quantity of stomach contents escaped Search revealed a perforated ulcer through

the anterior surface of the duodenum This was closed by a purse-string suture and the line of suture reinforced by an omental graft For drainage purposes tubes were inserted into the pelvis, renal fossæ and the lesser peritoneal cavity The patient failed to rally after the operation His condition became gradually worse and he died at 12 45 P M, November 18, 1918, as a consequence of a generalized peritonitis due to a perforated duodenal ulcer

CASE XXII—J A C, white, male, of Virginia, aged fifty-four, farmer, married, was admitted to the hospital June 4, 1919, for stomach complaint For the past year he had been having indigestion with attacks of pain in the epigastrium, but did not vomit, nor did he give history of the presence of any blood in the stools The pain was either before or after meals and occurred with no reference to periodicity or regularity About two weeks previous to admission the indigestion became more pronounced and he had several attacks of vomiting At this time he noticed that the stools were black Two days before admission he was suddenly seized with sharp pain in the epigastrium He felt something break inside Following this catastrophe he passed blood per rectum Muscular rigidity extended over the entire abdomen, but was especially marked in the right hypochondriac There was no evidence of jaundice

Operation, June 4, 1919, ether anæsthesia, iodine technic, enterorrhaphy and appendectomy, died The abdominal cavity was reached through a right rectus incision After getting into the peritoneal cavity investigation revealed an ulcer which had perforated through the anterior wall of the duodenum It was situated but a short distance from the pylorus The appendix was found to be the seat of a chronic inflammation The rent in the duodenum was closed with a purse-string suture and the appendix removed, and tube drainage instituted The day following the operation the temperature and pulse began to flare up and the patient complained of nausea but did not vomit By June 9th the condition had become progressively worse, the pulse dicrotic and weak and the patient expired June 13, 1919

CASE XXIII—W G, white, male, aged sixty-five, came to the hospital February 12, 1920 His first complaint was acid stomach in spells This started three years ago These attacks finally became more frequent and annoying, necessitating for their relief food or bicarbonate of soda Of late he has been compelled to take food to bed for consumption in the middle of the night However, the trouble did not materially interfere with his comfort until about ten days before admission to the hospital, when he was seized with an acute exacerbation of pain and had been having unendurable pain ever since He had vomited on occasion, but had never noticed any blood in the vomitus On admission examination of the abdomen showed it to be markedly distended, especially in the upper quadrants The liver dullness had entirely disappeared The muscles of the upper abdomen were rigid and the epigastrium and right upper quadrant were exquisitely tender to pressure He complained of spasmodic pain in this region On February 15th he became worse The pain was more intense and he vomited Although the X-ray examination suggested an old pneumothorax of the right lower chest, the clinical signs seemed to indicate an ulcer of the stomach or duodenum, consequently the clinical impression was rendered ulcer of the stomach or duodenum, probably perforated and shut off An operation was recommended as the only hope of preserving life It was accepted

Operation, February 16, 1920, gas and ether anæsthesia, iodine technic, gastrorrhaphy and posterior gastroenterostomy, died The abdomen was entered through a right rectus incision, when the peritoneum was opened the liver was found adherent to the parietes Upon liberation of these structures a quantity of gas with colon bacillus odor escaped The stomach was bound down to the surrounding structures by many adhesions When these were separated suffi-

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ciently to permit delivery of the stomach a small perforation was detected in its anterior wall near the lesser curvature. This was closed with two rows of sutures followed by a posterior gastroenterostomy. The patient stood up well under the operation. Following the operation, however, there was much drainage from the wound, elevation of temperature, quickening of pulse, but no vomiting or pain. This condition increased and he died February 18, 1920, apparently from general sepsis. At autopsy there was no peritonitis, but the sutures had failed to hold and there was leakage from the stomach.

CASE XXIV—J G, white, male, aged twenty-two, married, entered the hospital April 12, 1920, with the complaint of sharp, excruciating pain in the epigastric region which caused him to double up like a jack-knife and he was unable to straighten out. The patient had been troubled with indigestion for the past three years and frequently had pain one-half hour after eating, from which he obtained relief by vomiting. He had never noticed any blood in the vomitus, nor in the stools. The abdomen was extremely rigid throughout, but more marked in the epigastrium. This region was also very tender to pressure. Clinical impression. Ruptured gastric or duodenal ulcer.

Operation, April 12, 1920, ether anæsthesia, iodine technic, gastrorrhaphy and posterior gastroenterostomy, cured. The damaged organ was reached through a high right rectus incision. On examining the stomach a hole was found in its anterior wall in the neighborhood of the pylorus. This was sutured and the line of suturing capped with an omental graft followed by a posterior gastroenterostomy. The pelvis was drained through a stab wound above the pubes and the upper abdomen through the original incision. The man made a very smooth recovery and was discharged April 26, 1920, cured.

CASE XXV—J C, white, male, aged fifty-three, laborer, married, was admitted to the hospital October 25, 1920, through the dispensary, for stomach complaint of ten years' duration. The trouble began as a small area of localized pain in the epigastrium, coming and going at intervals. About six years ago the pain became more diffuse, spreading all over the abdomen. Eating was followed by much gastric distress and pain. The pain during the latter part of the illness was more or less constant, varying in intensity and greatly aggravated about three hours after eating. By vomiting alone could he obtain relief. The vomitus was greenish at times, and on other occasions yellowish or chocolate colored. It varied in amount from a quart to a half gallon. He never noticed any blood in the vomited matter. He stated the vomitus contained very little food particles. About five weeks previous to entrance into the hospital he noticed a small amount of blood in the stool. The pain was sharp, began in the epigastrium and radiated upward into the thorax and backward to the back. It was accentuated at night and when it was at its worst gave him the sensation of knots in both sides of the abdomen. At the time of admission the abdomen was slightly distended, but no masses could be detected. The history of this case was most suggestive of ulcer at the pyloric region. Other physical examination, save for evidence of underweight and undernutrition, slight rigidity of the recti, especially above, and a moderate amount of tenderness to the right of the midline in the epigastrium, was without note. The Röntgenological examination showed (1) Gastric dilatation, (2) blunt end at pylorus, (3) no filling defect, (4) cap not visible, (5) duodenum does not fill, (6) lack of normal emptying power of the stomach (gastric stasis, twenty-four hours). The laboratory findings were without note. Clinical impression. Pyloric obstruction due to pyloric ulcer.

Operation, November 10, 1920, ether anæsthesia, iodine technic, posterior gastroenterostomy, died. The stomach was exposed through a right rectus incision. There seemed to be a mass around the pylorus which was taken for a carcinoma, especially as the mesenteric glands were enlarged, so a posterior

gastroenterostomy was done and the abdomen closed. From the day of operation to November 11, 1920, the patient failed slowly but steadily, on which date he died.

Autopsy A complete necropsy was done, but the only findings of interest were. The peritoneal cavity, especially on the right side, contained a fair amount of free pus which was yellowish and blood tinged. The loops of intestines had a tendency to adhere to each other, but could be readily separated. The gastroenterostomy hole was healthy and there was no evidence of any leakage. There was no thickening nor tumor mass in the region of the pylorus, but one inch from the pylorus in the duodenum there was an ulcer 30 mm long with indurated edges. It was rather sinuous in outline and extended through all the coats including the peritoneal, leaving an opening 8 mm in diameter. Its edges were not rough. This perforation was on the under surface in close proximity to the head of the pancreas. There were some adhesions in this region which were fairly well organized. The duodenum as well as the small and large intestines contain free and clotted blood.

Anatomical diagnosis Perforating duodenal ulcer with hemorrhage and acute diffuse peritonitis. Cultures made from the pus showed colon and other intestinal organisms.

Microscopical diagnosis Perforated duodenal ulcer with carcinomatous changes. Chronic diffuse pancreatitis, pancreatic area beneath ulcer showed infiltration with carcinomatous cells.

Stomach analysis Free HCl, 34, comb HCl, 12, organ acids and acid salts, 8. Total, 54.

Stool negative for occult blood. Blood type group IV. Hæmoglobin, 75 per cent, red blood-cell count, 5,400,000, white blood-cell count, 4500, polymorphonuclears, 58, small lymphocytes, 35, large mononuclears, 6, eosinophiles, 1 per cent.

CASE XXVI—R. G., colored, male, married, laborer, aged forty-four, was admitted to the hospital December 27, 1920, with the following history. About twelve hours ago he was taken suddenly ill with abdominal pain which produced great shock. The trouble began two years ago with pain in the stomach which was treated for indigestion. The pain was knife-like and occurred about one-half hour after eating. It continued to get worse until relieved by the next meal. During the past year the pain was more or less constant, but was much worse on an empty stomach and somewhat relieved by food. Its point of greatest intensity was just below the ensiform cartilage, but on occasion involved the whole abdomen. He was never nauseated nor did he vomit, but he did suffer from some heartburn. He was very constipated and would go four or five days without a passage. He had never noticed any tarry stools. He had worked steadily up to the time of being taken seriously ill. Entrance examination showed a markedly distended abdomen which was exquisitely tender. He complained continuously and bitterly of severe pain. The pulse was fast, the temperature elevated, and the facial expression anxious. The white-cell count was 10,000, the differential picture, polynuclears 84, small mononuclears 14, large mononuclears 2 per cent. Impression. Perforated gastric or duodenal ulcer, peritonitis.

Operation, December 27, 1920, ether anæsthesia, iodine technic, gastrorrhaphy, followed by subphrenic abscess, died. After opening the peritoneum through a right rectus incision search revealed a perforated ulcer in the anterior wall of the stomach near the pylorus. This was sutured and five cigarette tucks and one tube used above and three cigarette wicks and one tube in the pelvis for drainage. The patient did very well until January 29, 1921, when his temperature which had been normal for some days jumped up to 102 degrees F, pulse 120, respirations 30, from then until February 16, 1921, he ran a low-grade fever. About this

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time suspicions of a subphrenic abscess arose. These suspicions were confirmed by X-ray examination and aspiration. On February 17th, an incision was made in the tenth intercostal interspace and a quantity of pus evacuated from between the liver and the diaphragm. The patient failed to rally, however, and died on February 22, 1921.

CASE XXVII—G B, white, male, fifty-eight years old, blacksmith, something less than a year ago had the left leg amputated in this hospital for an old fracture-dislocation at the ankle. He made an uneventful recovery and with the use of an artificial leg had been for some time following his trade. Around 5.30 in the afternoon of February 27, 1921, he had a sudden seizure of severe agony in the diaphragmatic region. He was not sure whether the pain was in the upper abdomen or lower chest. The pain was very severe and he went into immediate collapse. When seen about three hours after the onset of the attack he was complaining chiefly of pain in the chest and embarrassment of respiration. His abdomen was rigid and he was in a state of shock. Soon thereafter improvement set in. He was, however, sent to the hospital for observation as there was doubt as to the diagnosis. There he was seen by a number of men on the staff and the following diagnoses were considered: (1) Perforated gastric or duodenal ulcer, (2) mesenteric thrombosis, (3) ruptured aneurism, (4) acute pancreatitis. Immediately after admission to the hospital the man's condition continued to improve. His abdomen became soft, pulse better, temperature normal. The leucocyte count was 17,000. Later in the day his abdomen became stiff and it was believed that he had a perforated gastric ulcer and immediate operation was advised.

Operation, February 27, 1921, ether anæsthesia, iodine technic, enterorrhaphy, later subphrenic abscess, died. The abdomen was opened by an upper right rectus incision and a perforated duodenal ulcer found immediately beyond the pylorus in the anterior wall of the gut. The opening was closed and the abdomen and pelvis drained by two cigarette wicks and two tubes. On March 18, 1921, the man was taken suddenly worse, the pulse became weak and the patient complained of pain in the upper left abdominal quadrant. He was therefore aspirated through the eighth left interspace immediately beneath the angle of the scapula and a black pungent fluid withdrawn. He was too ill to be X-rayed. This was supposed to be a left subphrenic abscess or an infarct of the lung. The patient failed to rally and died at 8 P M, March 24, 1921.

Autopsy, March 25, 1921. Other than the following the findings were of no interest. The stomach was normal, the pylorus patent. Immediately beyond the pylorus was a small punched-out ulcer in the anterior wall of the duodenum. The covering immediately over the ulcer showed the silk sutures put in at operation. There had been no leakage. The intestines were shiny and glistening everywhere. A large abscess was found beneath the diaphragm on the left side. It was bounded below by the cardiac end of the stomach and the spleen. The abscess communicated with the lesser peritoneal cavity which in turn communicated with the drainage tract.

CASE XXVIII—C W, white male, aged thirty-nine, laborer, entered the hospital the night of April 3, 1921, on account of excruciating pain in the upper left abdominal quadrant. During the preceding sixteen months he had been suffering with indigestion and pain in the abdomen which came on half an hour after eating. This pain was relieved by more food or bicarbonate of soda. He was nauseated and vomited at times. He was seen two days previous to admission to the hospital and a provisional diagnosis of ulcer of the stomach made. He had been working as a wheelwright steadily and worked the day he sought entrance into the hospital. About 7 P M, April 3, 1921, he became nauseated and in striving to vomit was seized with a sharp, stablike, agonizing pain in the upper

abdomen. He collapsed and would have fallen to the floor, had his wife not caught him. The pain radiated toward his heart. He was seen one-half hour after the onset of this attack. At that time he was in collapse and bathed in a profuse sweat. His skin was cold and clammy. The left thigh was flexed on the abdomen and he begged piteously for relief. His upper abdomen was slightly tender and rigid but within a very short space of time the rigidity extended to the entire abdomen. A diagnosis of perforated gastric ulcer was made, operation advised and accepted.

Operation, April 3, 1921, ether anæsthesia, iodine technic, gastrorrhaphy, pneumonia, died. The abdomen was approached by an upper right rectus incision. As the peritoneum was opened, there was a gush of gas and about one-half pint of bile-stained fluid was found in the peritoneal cavity. Further search revealed a perforation in the anterior wall of the stomach. It was three-eighths of an inch in diameter, situated in the lesser curvature, in close proximity to the cardiac orifice. The indurated area was one and one-half inches in diameter. The rent was closed by mattress sutures and capped by a piece of free omentum. A stab wound was made in the right loin beneath the liver and a tube inserted down to the kidney shelf. A second opening was made above the pubes for tube drainage of the pelvic basin. As additional safeguards tubes and cigarette tucks were placed in the upper abdomen through the right rectus incision. The patient was returned to his bed in fair condition. From operation until April 12, 1921, the man made satisfactory progress, but on that date developed a pneumonia in the right lower lobe and gradually sank until death April 14, 1921.

In this case the perforation occurred at 7 P.M., and the patient was on the operating table by 10 P.M. and off by 10.50 P.M., yet despite the early period he was gotten after rupture, he died. Before death all of the drains had been removed, the belly was soft and the bowels moving regularly. It serves well to illustrate the desperateness of the condition no matter how early after perforation the case is operated.

CASE XXIX—W. W., white, male, aged twenty-nine, sailor, entered the hospital April 29, 1921. While engaged in painting the side of a ship which was lying in the harbor, about 10 A.M., the day of admission, he was seized with a severe pain in the abdomen. He suffered a chilly sensation and vomited. As the day wore on the pain increased in severity and vomiting continued. The pain at first was diffused throughout the abdomen, but soon localized in the epigastrium. The patient stated he had had a similar attack of less intensity two weeks previously. The pain at that time, however, only lasted a few hours and he was soon able to resume his customary work. He had suffered but little disturbance since that time. There was no history of gastro-intestinal disturbances antedating these attacks. The man stated he had never suffered from indigestion and could eat anything he pleased. He entered the hospital at 5 P.M., at which time he was suffering intensely and was severely shocked. In bed he lay upon his right side with knees flexed on the abdomen. He did not vomit after entrance. The temperature by rectum was 99 $\frac{1}{2}$ degrees F, leucocyte count 24,000, pulse 80. He was operated upon at 7 P.M., at which time he had somewhat recovered from his shock. He denied luetic or Neisserian infection. In the first attack the man stated he both vomited and defecated blood. On admission his abdomen was boardlike and tender everywhere, especially in the epigastric region. Impression. Perforated duodenal ulcer.

Operation, April 29, 1921, ether anæsthesia, iodine technic, gastrorrhaphy, recovered. The abdomen was reached through a right rectus incision centring about the umbilicus. As soon as the peritoneum was opened a murky fluid escaped. This fluid contained shreds of yellowish fibrin. A round opening was found in the stomach immediately above the pylorus from which fluid was flowing

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copiously A purse-string suture of silk was thrown around the perforation and the aperture closed Another layer of sutures was then inserted and over all a strip of omentum was tucked Rubber tubes were placed in the right and left renal fossæ, two cigarette rolls over the suture and a large rubber tube introduced into the pelvic basin The man stood the operation very well The area around the ulcer was thick and œdematous which rendered suturing difficult, as there was a tendency for the sutures to cut out After operation the patient made satisfactory progress There was scarcely a ripple in the smoothness of his convalescence He was discharged from the hospital June 10, 1921, cured

PERSISTENCE OF GASTRIC ULCER AFTER GASTROENTEROSTOMY

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THE surgical procedures that have been advocated and performed for the cure of gastric ulcer are

- 1 Gastroenterostomy with or without pyloric exclusion
- 2 Excision of the ulcer either by the knife or cautery
- 3 Excision of the ulcer combined with gastroenterostomy
- 4 Segmental or "sleeve" resection, either alone or combined with gastroenterostomy
- 5 Partial gastrectomy
- 6 Pyloroplasty with or without excision of the ulcer

During recent years there has been an increasing tendency toward the performance of the more radical procedures. However, a large group still maintains that gastroenterostomy gives the best postoperative results. Professor Sherren,¹ in his Hunterian lecture, states that no definite rule can be laid down, but nevertheless leans decidedly toward gastroenterostomy. He says, for instance, "Gastroenterostomy is still the operation of choice in the majority of cases," and, "this (gastroenterostomy) will bring about permanent healing in free ulcers, those that have perforated and have an adherent base or floor formed, usually of liver or pancreas, do not completely heal after this procedure alone." Paterson² believes that when the operation is properly performed it is as satisfactory as any major surgical operation, and that the failures do not exceed 7 per cent. Coffey³ very stoutly maintains that gastroenterostomy is "still the treatment for chronic gastric and duodenal ulcers." And others who lean strongly toward this procedure as the operation of choice are Metraux,⁴ Zacherl and Landes,⁵ Borchgrevink,⁶ Kuttner,⁷ Rowlands,⁸ and Gallart and Ribas.⁹

The numerous failures following gastroenterostomy have, however, led to a far more insistent note of dissatisfaction. There is no doubt that when this operation is performed for gastric ulcer the following sequelæ may ensue.

1 Hemorrhage. This does not refer to immediate postoperative bleeding, but to late hemorrhage. Eggleston¹⁰ tells of a patient who had two severe hemorrhages from the stomach before operation, and then in spite of a gastroenterostomy for the cure of his ulcer had three more. His series showed that in 11 per cent of the cases subjected to operation hemorrhage occurred some months or years after the operation. (No tables are given, but he states that the operation usually performed was gastroenterostomy, and his series includes both gastric and duodenal ulcers.) Balfour¹¹ found

that in 8 per cent of the patients who had had hemorrhages before operation the bleeding recurred, and in 3 per cent of those who had no hemorrhage previous to surgical intervention it subsequently developed Coffey,³ a staunch advocate of gastroenterostomy, says "a few of the cases had severe hemorrhages several months or years after operation" Moynihan¹² also calls attention to the occurrence of late hemorrhage and reminds of the fatal cases that have been reported by Kocher, Quénu, and Eve Zweig,¹³ in a recent paper devoted to this subject, found that among seventeen patients in whom a gastroenterostomy had been performed for the treatment of bleeding peptic ulcer the hemorrhages persisted or recurred in fourteen Seven of the latter were reoperated upon In three the original ulcer was found unhealed, and in the other four a gastrojejunal ulcer had produced the bleeding Zweig also mentions Von Petren's statistics where 74 per cent of 203 gastroenterostomies had hemorrhages after operation, and Rovsing's tables, in which the percentage was 10 per cent

2 Perforation of an unhealed ulcer Moynihan,¹² Von Haberer¹⁴ and Troell¹⁵ each report fatal cases of perforation following gastroenterostomy that had been performed for ulcer (Gastrojejunal ulcers are not included)

3 Carcinomatous degeneration It makes some difference whether we believe that 2 per cent of ulcers degenerate into carcinomata or that 60 per cent do so Nevertheless, both views concede the possibility of such an occurrence, and render the ulcer a continuous potential danger Further, one cannot always differentiate on the operating table between ulcer and carcinoma In Von Haberer's¹⁴ series five specimens that were believed to be typical ulcers at the time of the operation were under the microscope found to be carcinomata The routine removal of all ulcers certainly gave these patients a better fighting chance than had the routine been merely to perform a gastroenterostomy, and the apparently benign gross appearance of the lesion would not have created a contraindication to the latter operation

4 Persistence or recurrence of gastric symptoms Some one has said, "Statistics may be made to prove anything, even the truth" Perhaps that accounts in part for the fact that Metraux⁴ can report from Roux's service 90 per cent cures following gastroenterostomy (only twenty-seven of the 210 cases were duodenal, the rest being pyloric and gastric ulcers), while on the other hand, Denéchau¹⁶ could find only 20 per cent of excellent results in fifty-one cases of gastric ulcer traced over a period of from four to twelve years Human nature being prone to honest prejudices, comparative series of failures and successes—and enough of them can be adduced to favor either side—apparently prove very little If on the other hand it is shown in enough cases that the persistent or recurrent symptoms are due to the serene unconcern of the ulcer in spite of a gastroenterostomy, such evidence will be of much more tangible value It is true that some of the failures after this operation are due to technical errors What the percentage is we do not know Yet the suspicion is often aroused that what is attributed to an error in technic may in reality be due to the original ulcer The occurrence of late

hemorrhage after gastroenterostomy certainly adds strength to such a view

Direct evidence of the persistence of ulcers after gastroenterostomy is afforded by the cases reported by Von Haberer¹⁴ In his first case, a gastroenterostomy performed by von Eiselsberg, a subsequent pyloroplasty and gastropasty, together with a jejunostomy, were all without effect on two large ulcers (There is no mention of the size and fixity of these ulcers at the time of the first operation) In the second case, a gastroenterostomy was done for an ulcer on the lesser curvature which was freely movable, and therefore according to Sherren a proper procedure Nevertheless, a few months later at a second operation, the ulcer was found to have thrived so well that it had penetrated into the liver and pancreas In a third case an ulcer on the lesser curvature and an ulcer at the pylorus persisted in spite of a gastroenterostomy with enteroanastomosis These three cases were all cured by partial gastrectomy Moynihan¹⁷ also mentions the fact that in some of the cases which he reoperated the ulcer was still open and had usually perforated and become adherent to the liver

Still more interesting are the cases where typical gastric ulcers developed in the very face of a gastroenterostomy (Gastrojejunal and jejunal ulcers are not included) Moynihan¹⁸ tells of two patients in whom gastroenterostomies were performed where at the time of the operation the stomach was found normal, the gastroenterostomies presumably being done for duodenal ulcer Typical gastric ulcers, well away from the line of the anastomosis, subsequently developed Carter¹⁹ reports that Moynihan later had a third case Coffey⁸ also had a patient in whom after a gastroenterostomy with pyloric exclusion an ulcer developed in the stomach distal to the anastomosis Kotzareff and Balmer²⁰ describe a case where an ulcer developed on the lesser curvature It hardly speaks well for this operation when the condition which it is meant to cure may sometimes develop in spite of the fact that it has already been performed

Below is reported a case where an ulcer situated on the lesser curvature in the centre of the antrum persisted following a gastroenterostomy Ulcers in the antrum and pylorus have been believed to yield especially well to gastroenterostomy

Miss W, a private patient of Dr A A Berg, with a negative past and family history, had been sick for six years previous to her admission to the hospital She was seized with intense pain in the epigastrium coming on about two hours after meals This pain was not relieved by taking food or soda, but ceased spontaneously after about an hour She lost twenty pounds in weight The pains were present for a few months and then were followed by a variable interval of several weeks or months in which she felt better An X-ray taken in February, 1918, revealed the presence of a gastric ulcer On March 13, 1918, a gastroenterostomy was performed by a surgeon of wide experience

She was relieved of her symptoms only five weeks, when they all

returned with increasing severity. The pain, coming on about one or two hours after each meal, was especially severe. Nausea was present almost all day. There was no vomiting. Loss of weight continued until on her admission to the hospital she weighed eighty-five pounds. X-ray and fluoroscopic examinations performed by Dr. E. A. Aronson showed a normally situated stomach, marked hypermotility and exceedingly rapid evacuation through the stoma. There was no six-hour residue.

On June 8, 1919, Dr. A. A. Berg reoperated. The gastroenterostomy stoma was found to be about one and three-quarters inches long and was apparently functioning properly. There was no evidence of ulceration in any part of its circumference. The jejunum also was healthy. Exploration of the rest of the stomach revealed, however, the presence of an ulcer on the lesser curvature about one inch from the pylorus. The ulcer was perfectly free and not adherent to any of the neighboring organs. The gastroenterostomy stoma was proximal to this ulcer. A partial gastrectomy was then performed according to the Billroth II method, the antrum being removed up to a point proximal to the ulcer. The existing gastrojejunostomy was left intact. Further examination of the stomach and duodenum during this procedure did not show the presence of any other ulcer or the scar of a healed ulcer. The stomach and the first portion of the duodenum were examined interiorly as well as exteriorly.

This patient is now perfectly well one year after the operation. She has gained thirty pounds in weight, eats anything, and, in the words of Von Haberer, "is unconscious of the fact that she has a stomach."

Inasmuch as her symptoms returned five weeks after her first operation,—a well-performed gastroenterostomy,—and inasmuch as a very careful search failed to reveal the presence of a scar that would be left by a previously healed ulcer, it seems certain that she was suffering from this same ulcer at the time of her previous operation, and that the gastroenterostomy performed for its cure was entirely without effect. It should again be emphasized that this ulcer was near the pylorus and that it was not adherent to any of the neighboring organs.

There is no intention in this paper to discuss the relative merits of the other surgical procedures for the treatment of gastric ulcers. It is merely intended to add a little further evidence to the view that has steadily gained ground, that no matter what procedure is used, it should, if at all possible, include removal or destruction of the ulcer. That this view is, however, by no means generally accepted is shown by the number of distinguished men mentioned in the beginning of this paper who still lean most strongly to gastroenterostomy.

The most important argument advanced against the radical procedures, such as partial gastrectomy, is the higher mortality of this operation as compared to gastroenterostomy. But such an argument is really not fair. None but members of the extreme right wing will deny that a gastroenterostomy alone is of very little value in the treatment of, let us say, an ulcer on

the posterior wall, perforated and adherent to the pancreas. Here the ulcer must also be attacked, for instance by a partial gastrectomy (others will prefer excision), if a cure is to be predicted with reasonable frequency. It is therefore not fair to place the mortality rate of gastroenterostomy against that of gastrectomy. In a large number of severe cases which the latter operation cures the former is entirely without effect and might just as well not have been done. It would be almost as logical to compare the mortality rate of inguinal herniotomy with gastrectomy.

As regards the mortality of partial gastrectomy, there can be no doubt that with the improvement of technic it will be lowered. It may be interesting to add that when Von Hacker,²¹ in 1895, reported concerning the gastroenterostomies that had been performed in Billroth's clinic from 1880 to 1894, there was a mortality of almost 51 per cent. To-day that figure has shrunk to from 2 to 4 per cent.

SUMMARY

1 Gastroenterostomy performed for the cure of gastric ulcer may be followed by—

- a Hemorrhage. In one-half of the cases this probably comes from the unhealed ulcer.
- b Perforation of an unhealed ulcer.
- c Carcinomatous degeneration of the ulcer.
- d Persistent or recurrent gastric symptoms. In some of the cases these symptoms are due to the unhealed ulcer.

2 Gastric ulcers may develop in the stomach in the presence of a gastroenterostomy. This does not refer to gastrojejunal ulcers.

3 A case is reported where the persistence of gastric symptoms was due to an unhealed prepyloric ulcer following a well-performed gastroenterostomy. The symptoms yielded to partial gastrectomy.

4 If at all possible the surgical treatment of peptic ulcer should include the removal or destruction of the ulcer.

5 It is unfair to compare mortality statistics of partial gastrectomy and gastroenterostomy, since the former operation can cure severe cases in which the latter is entirely without effect and might just as well not have been done.

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JEJUNAL DIVERTICULA

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THE purpose of this communication is to place on record two cases of diverticulum of the upper third of the jejunum, in one of which the diagnosis was made by the X-ray and confirmed by operation wherein the diverticulum was removed with recovery of the patient and relief of symptoms, while in the other a diagnosis of appendicitis was made, a fatal result followed appendectomy and autopsy revealed a diverticulum

Hitherto much has been written of diverticulosis of the colon and more recently of the duodenum. An article by William Mayo,¹ in 1917, covers the former, and articles by Case,² of Battle Creek, Roberts and Cole,³ and E. Willys Andrews⁴ within the past year cover the latter, so that a discussion of diverticulosis in general will not be attempted. It is because of the comparatively few cases on record of the particular lesion described, as well as the apparent fact that the condition comprises a clinical entity diagnosable and susceptible to specific relief by surgery, that we offer this report.

Referring briefly to Case's paper, we find that he was able to collect from the literature of the period 1854 to 1920 but seventeen cases in which diverticula of the jejunum were found at operation or autopsy. Of these four were single, and the rest multiple, one having four hundred sacculations. It is interesting to note that practically all are at or near the mesenteric attachment and when multiple may be associated with diverticula of other parts of the intestine and sometimes of the bladder.

To this list Case adds two detailed histories from his own experience, in both of which the diagnosis was made by X-ray and confirmed by operation. He also refers to three other diagnoses made, but which were not confirmed, as patients were not operated upon and therefore not included in his list. So far as we know, the honor of being the first to diagnose the condition prior to operation belongs to Case, we believe, however, that under the stimulation of his articles others like ourselves will find them out and one more "rare" condition will assume a position in the ranks of the relatively commonplace.

In support of our suggestion that the condition may be a clinical entity of some importance, we take the liberty to abstract the history of his first case, which was an adult male having a single large diverticulum near the duodeno-jejunal junction, in which the symptoms were "indigestion" for the preceding ten months, feeling of pressure and distention of stomach developing immediately after meals, causing much discomfort and distress, relieved

somewhat by belching of gas, no pain, no nausea and no vomiting, but occasional "heart-burn" at two A M and intestinal flatulence This large sac was associated with many small ones and was situated between the folds of the mesentery and devoid of muscularis Treatment was resection of 30 cm of the bowel

CASE I —E C, male, aged fifty-four Occupation, operative. His work required considerable sustained muscular tension but no direct pressure on abdomen Admitted medical, December 12, 1920 Service of Dr G A Tripp Chief complaint Stomach trouble

Past history negative up to present illness, which dates from fifteen months ago, since when he has lost fifty pounds in weight and feels "run down" His trouble began rather abruptly with epigastric pain, developing one morning after he had begun work and thereafter about ten minutes to one hour after meals, more recently as apt to come on with stomach empty and to be eased by taking food, but returning soon after The pain is located in middle epigastrium and radiates to right and back Patient is sure that he observed blood in stool a week ago, has no hemorrhoids, has never been nauseated nor has he vomited at any time

Physical examination Well-developed and nourished man in fair general condition

Central nervous system, heart, lungs, skin, genitals and extremities normal

Abdomen relaxed, soft, tympanitic, no area of localized tenderness, except rather vaguely deep in middle epigastrium By rectum Prostate is found slightly enlarged, no tenderness, swelling, hemorrhoids or fissure felt Temperature, 96.8° Pulse, 94 Blood-pressure, 90/60. December 18, 100/76

Urine December 13, 1920, acid, 1034, no albumen, sugar or bile

X-ray examination (December 18th) Regular gastro-intestinal series No abnormality shown in stomach or duodenum In region of jejunum and shown on a series of plates is a shadow about size and shape of the duodenal cap Diverticulum might produce such an appearance —P H Cook

Note —Sac had nearly emptied on six-hour plate and entirely on twenty-four hour.

Progress. House diet with meat

December 16th Patient's gastric distress seems to be of an indefinite character, pain and distress may come on twenty to forty-five minutes after meals or in the evening on empty stomach Still losing weight

Blood chemistry December 22nd Sugar, 11, creatinin, 11, urea nitrogen, 14, alkaline reserve, 65

December 12th Wassermann negative

December 21st Blood differential, polymorphonuclear, 76 per cent Lymphocytes, 20 per cent Eosinophiles, 3 per cent Mast, 1 per cent Reds show no abnormality, platelets present in average ratio to reds

December 22nd Whites, 7800, reds, 3,864,000

December 15th and 18th Examination of stools negative for blood
Phthalein test, December 16th, 58 per cent, two hours

December 23rd Urine, acid, 1032 No albumen, no sugar

December 21st X-ray examination repeated Diverticulum shows
as before, not visibilized by fluoroscope—P H Cook

December 24th Transferred surgical Operation December 29th

Operation Record Operator, Doctor Hunt, assistant, Doctor
Baxley Anæsthetic, ether, cone method, by Miss Fennell Preopera-
tive diagnosis Diverticulum of jejunum (by X-ray department)

Description of operation Right paramedian incision centering at
level of umbilicus Appendix pulled out and found to contain concre-
tions and was removed Systematic exploration of small intestine, be-
ginning at ileocæcal junction and carried upward, found three inches
below upper end of jejunum on the left side near the mesenteric attach-
ment, a diverticulum roughly pear-shaped and approximately three
cm deep and three cm broad Dissecting peritoneum around its
attachments, the communication with the intestine was found to be
about 1 cm in diameter The diverticulum was clamped at the neck,
tied off, amputated, and the stump buried by a double row of Lembert
sutures, the mesentery on that side being hooked up by a large suture
to serve as a buttress This procedure was carried out with very careful
protection of adjacent bowel by gauze Wound closed layer by layer

Condition of organs explored Gall-bladder, duodenum, liver, stom-
ach and colon normal Condition of patient as to shock, hemorrhage,
no apparent shock, no hemorrhage Post-operative diagnosis same
Operation by name Appendectomy, diverticulectomy

Pathological report, December 29, 1920 Diverticulum of intestine,
which on section shows a very thin muscularis with a thickened mucosa
The appendix shows moderate chronic fibrous changes—Dr F H
Baker

Progress Convalescence was uneventful, patient discharged as
"cured" January 17th, nineteenth day after operation

Follow-up note Returned to hospital April 1, 1921, having devel-
oped a ventral hernia in operation wound Has gained twenty-two
pounds in weight and had no recurrence of the symptoms which pre-
ceded the operation

The outstanding features of the symptomatology in this case are (1)
Rather definite onset (2) Rapid and considerable loss of weight (3)
Digestive symptoms consisting of pain and discomfort of rather uncertain
character, but in general, corresponding to the period when the sac might
be distended by partly digested food and radiating to the upper lumbar
region (4) Rather diffuse and inconstant tenderness in the neighborhood
of the sac The diagnosis depended upon the routine X-ray examination

It seems remarkable that so well-formed a sac which would *a priori* seem
to have existed much longer than symptoms attributable to it can be traced
should suddenly become an active source of serious disturbance without hav-
ing become subject to some superimposed condition such as ulcerative or in-



FIG 1 — Röntgenogram of Case 1 showing diverticulum with its relation to stomach and cecum

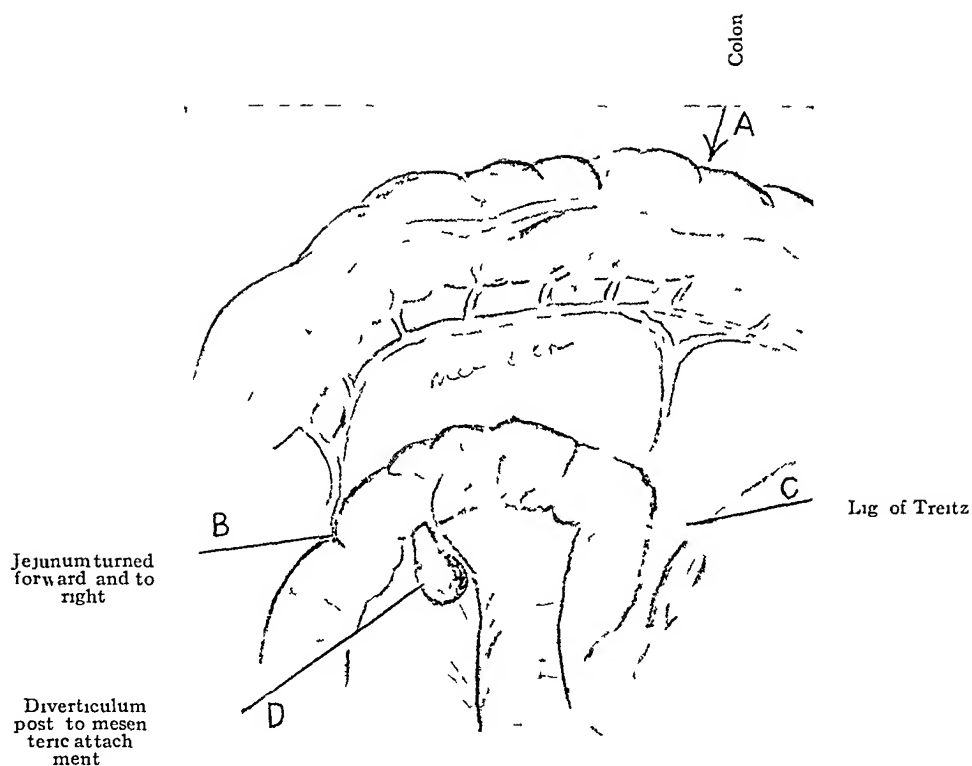


FIG 2—Sketch showing location of diverticulum and relations as found at operation in Case I



FIG 3—Section of jejunum from Case II removed at autopsy showing diverticulum protruding between cut edges of mesentery

flammatory changes If we can assume a sudden development of such a lesion from mechanical strain, it becomes less puzzling Doubtless herniation is a cause of many diverticula, as we not uncommonly find obvious herniation of mucosa in bowel distended from obstruction below and in such the muscularis is lacking in the sacculated portion In this instance the muscularis mucosæ is present, but the muscularis itself is found only in segments at the point of section, which was at the side of the sac, hence it is possible that by slow pouching the mucosa was driven through a defect in the muscular layer near a point of penetration by the blood supply The villi, glands of Lieberkuhn, and solitary follicles are present as normally found in the jejunum, and there is no evidence of any inflammatory process Symptoms must have been dependent upon distention when packed by intestinal contents and their development coincident with the attainment of a certain size in the pouching when immediate emptying was no longer possible

Bearing these symptoms in mind and remembering the possibilities of ulcerative, suppurative and carcinomatous developments upon such a lesion, it seems probable that it will be more frequently considered in differential diagnoses and its true importance discovered

The distinctive Rontgen findings in this case consisted of a well-defined shadow, of solid and constant density, uniform in its relation to the feathery coils of jejunum, yet movable independently of them The "fluid level," mentioned by Roberts and Cole, was not observed

CASE II — (By courtesy of a colleague) No. a-19666 Male, aged forty-four years, divorced, laborer in street department Entered April 3, 1921

Past History Negative, except for malaria as a young man Constipation associated with vertigo and diplopia recently Habits described as good and venereal not recorded No loss of weight or swelling of feet

Present Illness About twelve hours prior to entrance began to have sharp pains and general discomfort in abdomen, accompanied by dizziness and nausea, vomiting everything ingested during day Throat negative Chest lungs negative Heart slightly irregular with roughened aortic first No murmurs Blood-pressure, 134/88 Pulse, 80 Temperature, 99° White count, 8400 Hæmoglobin, 90 per cent Abdomen generalized tenderness in lower right and left quadrants with point of maximum tenderness two inches below McBurney's point. This tenderness is very acute on deep palpation Urine specific gravity, 1002, no albumen, no sugar

Preoperative Diagnosis Appendicitis, acute

Operation (ether, cone method) Found a retrocæcal adherent appendix five inches long which was removed with some difficulty and stump cauterized Pulse did not exceed 96 Good ether recovery

April 4, 1921 During forenoon had difficulty in speaking, followed in afternoon by inability to swallow Examination showed pharynx dry and insensitive with apparent paralysis of muscles of deglutition. Pulse remained of good character, 76 Temperature, 98.6°.

April 5, 1921 Died suddenly at 3 50 A M

Cultures Abdomen, no growth Throat, no diphtheria Pathological report chronic appendicitis, no marked changes Final diagnosis (clinical) appendicitis, chronic Acute bulbar paralysis

Autopsy Pia thickened and opaque over both hemispheres Section of brain showed no gross lesion Bronchi showed injection of mucosa with blood-tinged, frothy mucus Lungs œdematous, moderate passive congestion of liver and spleen Ecchymosis and a very little free blood about site of appendix, no peritonitis Forty centimetres below upper end of jejunum, lying between folds of mesentery, is a diverticulum, size of an English walnut Inflation of gut shows that its wall is much thinner than the intestinal wall There is no surrounding inflammation Kidneys enlarged, otherwise not grossly abnormal Anatomical diagnosis wound of recent appendix operation Lepto-meningitis, chronic Bronchitis, acute Diverticulum of jejunum

The cause of death in this case is obscure in spite of the autopsy The low specific gravity of urine with œdema of lungs suggests a toxic condition, while lepto-meningitis is consistent with syphilis A post-mortem Wassermann was negative

Our reason for reporting it lies in the presence of the diverticulum Could it not have been responsible for the symptoms attributed to the appendix? It will be noted that pulse, temperature and white count were but little disturbed, and while this is not extremely rare in very serious appendicitis, in this instance it may be interpreted as favoring the other hypothesis, moreover, the point of maximum tenderness was much below the actual level of the appendix

We cannot go so far as to advise the administration of a barium meal in the face of an acute abdominal crisis with vomiting, nor do we consider the possibility of such a lesion as a contraindication for prompt operation in such an acute abdomen, but would suggest that in event of finding the suspected lesion absent or insufficient to account for the symptoms, diverticulum be kept in mind and the small bowel explored from end to end In the less urgent cases and in obscure cases in general the possibility of these lesions should be carefully considered in the course of the routine Rontgen examinations of the gastro-intestinal tract

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RADIUM TREATMENT OF CARCINOMA OF THE BLADDER

BY BENJAMIN S BARRINGER, M D

OF NEW YORK

CLINICAL REPORT FROM THE MEMORIAL HOSPITAL, OF NEW YORK

THE treatment of carcinoma of the bladder at the Memorial Hospital has been divided into two periods, *viz*, that prior to June, 1919, when we were testing what could be done with radium applied through the urethra and without opening up the bladder, and that period since June, 1919, when we have added to the intraurethral treatment the application of radium through the bladder opened suprapubically. The object of this latter phase was to destroy extensive bladder carcinomata which we had not been able to cope with through the urethra. The results of both these forms of treatment are herein reported and this paper is based upon all cases seen at the Memorial Hospital up to January, 1921, a period of nearly five and a half years. One hundred and forty-two cases of advanced carcinoma, four cases of small carcinoma, nine cases of extensive papilloma, two borderline cases.

Pathology—Classification—In fifty-three cases of tumor of the bladder the pathological examination (Ewing) was as follows. Papilloma, seven cases, papillary carcinoma, eighteen cases, infiltrating carcinoma (variously called epidermoid carcinoma, malignant epitheliomata, papillary infiltrating carcinoma), twenty-two cases, adenocarcinoma of prostatic type (alveolar carcinoma), four cases, papillary adenocarcinoma, one case.

I can see no reason for making another class "malignant papilloma," which means that a tumor purely papillomatous in histological structure, either by its rapid growth or rapid recurrence after removal, shows more malignant tendencies than the usual papilloma. The term "malignant papilloma" refers to a clinical rather than a histological difference. In these fifty-two cases there was but one which could not be classified under the above heading, that of papillary adenocarcinoma. The four cases of alveolar carcinoma were probably secondary to a prostatic carcinoma.

Papillary Degeneration into Carcinoma—There has been much written over the fact that papillomatas may remain such for a long period and then take on a carcinomatous degeneration (Mandlebaum, *the Pathology of New Growths of the Bladder, Surgery, Gynecology and Obstetrics*, September, 1907, Buerger, *Trans of A U A*, 1915). The basis for this rests upon two findings.

1 Clinical. A pure bladder papilloma may be observed at one time (cystoscopically and by pathological specimen), and a number of years later a well-developed carcinoma identified.

2 Pathological. The fact that a tumor shows in one part pure papilloma and in another part carcinoma may indicate that a benign papilloma has become carcinomatous.

We have seen patients with extensive papillomata of the bladder with histories dating back four, five, six years and more which showed at the time of examination no malignant changes (pathological examination, Ewing), and which had no induration at the base of any of the multiple tumors. We have also seen patients with carcinoma of the bladder (identified pathologically and cystoscopically) live for a number of years with their carcinomas. Our observations lead us to believe that many bladder tumors run true to their original histological structure. Many papillomata begin and end papillomata, and many carcinomas begin and end as such. We must, however, not forget that malignant degeneration may take place in a papilloma and therefore papillomata are potentially malignant.

History—Age first seen—125 cases (121 extensive carcinoma, four small carcinoma). Twenty to thirty years, three cases, thirty to forty years, sixteen cases, forty to fifty years, twenty cases, fifty to sixty years, thirty-seven cases, sixty to seventy years, thirty-five cases, seventy to eighty years, fourteen cases.

The fifth and sixth decades showed the greatest incidence of carcinoma. Nine extensive papillomata of the bladder gave four cases between fifty and sixty, two cases between sixty and seventy, one case between seventy and eighty. So giving about the same age incidence as carcinoma.

Duration of Symptoms—One hundred and twenty-one cases (116 advanced, five early carcinoma). One to three months, fifteen cases, three to six months, fourteen cases, six to twelve months, thirty-five cases, twelve to eighteen months, nine cases, eighteen to twenty-four months, sixteen cases, twenty-four months, 32 cases.

These tables emphasize that most patients with carcinoma of the bladder have symptoms for a year or more before their condition is seriously considered. If they could be seen earlier very many more could be cured.

Among the cases of extensive papilloma was one with symptoms dating back six years, he had extensive solid papillomata almost filling the bladder. There was no induration of the base of any of these, pathological examination (Ewing) showed papilloma. One extensive carcinoma of the bladder had bladder symptoms dating back fourteen years.

Sex—On hundred and fifty-three cases—male, 119, female, thirty-four. This preponderance of males may signify that inflammation may be a causative factor in carcinoma of the bladder. Prostatitis and trigonitis (gonorrhoeal) have no analogue in the female.

Loss of Weight and Strength—Of 126 cases (124 advanced carcinoma), thirty-nine cases showed a decided loss of weight. Loss of both weight and strength is commonly supposed to be an accompaniment of malignant disease. These two as a symptom of bladder carcinoma generally appear late. In our records there are a good many cases of bladder carcinoma, too advanced for any therapy, which have kept both their weight and strength up to the time when seen. If the loss of weight be due directly to the carcinoma and not

RADIUM TREATMENT OF CARCINOMA OF THE BLADDER

secondary as *e g*, serious infection of the kidneys, then one may suspect that the carcinoma has grown beyond the bladder

First and Second Symptoms—One hundred and thirty-eight cases (135 advanced carcinoma, three small carcinoma)

Hæmaturia—First symptom, seventy cases, second symptom, sixty cases; no hæmaturia, eight cases This symptom of tumor of the bladder therefore appeared in 130 out of 138 cases In recognizing this as a cardinal symptom in early cystoscopy and appropriate treatment thereafter lies the solving of the question of carcinoma of the bladder

In eight extensive papillomas of the bladder, but one gave no history of hæmaturia

Disturbance of Urination—One hundred and eighteen cases (116 advanced carcinoma, two small carcinoma), first symptom, fifty-eight cases, second symptom, fifty-two cases

The carcinoma in the majority of cases causes some urinary disturbance Frequent urination, dysuria, polyuria, retention, incontinence

Loss of Weight (116 cases) —First symptom, no cases, second symptom, five cases Loss of weight comes on late in the disease

Pain Down Leg (116 cases) —First symptom, no cases, second symptom, three cases

This symptom so often seen in prostatic carcinoma is comparatively rare in bladder carcinoma and is almost always an index of nerve involvement by the carcinoma beyond the bladder.

EXAMINATION—*Cystoscopy* 1 Presence of Tumor 2 Carcinoma or Papilloma Usually the cystoscopic diagnosis is not difficult If there is fresh bleeding, the best view of the bladder and tumor is made during irrigation The red, fluffy papilloma may be confused with blood clots, and the gray, sloughy carcinoma with calcareous incrustation of the bladder The examination of pieces of tumor obtained with the rongeur forceps (cystoscopic) or sticking to the cystoscope may confirm the diagnosis Pieces of the white, sloughy portions of a tumor usually show nothing diagnostic microscopically

Carcinoma or Papilloma—It probably falls to our lot at the Memorial Hospital to see more carcinoma than papilloma In five years we have seen very few, not more than five or six, papillomas which have been suitable for destruction by fulguration* We have also seen many patients whose tumor has been fulgurated at length and often before they came to us with full-blown carcinoma Extensive tumors of the red papillary type should be suspected of being carcinomatous, notwithstanding the oft-returning pathological report "papilloma" The more a tumor tends towards the flat type, the more malignant is it.

A raised thickened base means carcinoma All sloughy tumors are carcinomatous

* These are not included in this report

Rectal Examination —If there is extensive induration of the bladder base, that is an indication that the tumor has grown through the bladder. If the tumor or its base is felt, but, between the tumor and the examining finger, is interposed somewhat soft bladder wall the case is still suitable for exploration. In a number of such cases we have removed the tumor from the bladder for various periods of time. The examination should be made with a thin-gloved finger, the bladder must be empty of fluid.

Residual Urine —This is rarely present if the prostate is not primarily involved and should always suggest the possibility of this.

Kidney Function —In ten out of fifteen cases (operated upon) the kidney function was reduced. In a few instances this reduction was marked, the lowest phenolsulphonephthalein output being 5 per cent in the first hour and 7 per cent in the second. This reduction in kidney function which occurs in perhaps two out of three cases of carcinoma of the bladder is of importance in determining the length of the operation, the kind of operation and the prognosis. We have had three interesting kidney conditions following the use of radium.

CASE I —J A H, who had an infiltrative carcinoma of the right side of the bladder near the right ureter orifice. This was small and operable. It has been destroyed by radium now for four years. He also had retention of urine and a hypertrophied prostate. In the midst of his radium treatment he had a stormy time with retention of urine and pyuria. About a year ago it was determined that his kidney corresponding to the side occupied formerly by the carcinoma was a pyonephrotic sac. Either the carcinoma encroaching upon the ureter or cicatrization by the radium caused this kidney's destruction.

CASE II —K B Had an extensive carcinoma of her bladder around the right ureter. Previous to radium treatment she had several very severe attacks of renal colic on the side corresponding to the tumor. For ten months subsequent to radium treatment she had no more attacks of renal colic. The tumor was by no means entirely gone, but apparently that portion around the ureter orifice was destroyed, so relieving her of the attacks of colic.

CASE III —B, who had an extensive papilloma of the right side of his bladder. He had previous to operation a phenolsulphonephthalein output of 5 per cent the first hour, and 7 per cent the second hour. His bladder was opened suprapubically, the tumor snared off and radium imbedded in the base. For a number of weeks he ran a slight temperature, then considerable temperature and was found to have a large right kidney. His condition became progressively worse. I opened his kidney under novocain and found it to be hydronephrotic with the urine under tension and with pus in the kidney pelvis. This was drained, the patient became better for a number of weeks, then died septic.

Cystogram —We have used the following technic at the Memorial Hospital to graphically show the tumor and the infiltration of the bladder wall.

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The patient is placed flat on his back, a catheter is introduced into his bladder, and the contents emptied. With a large syringe the bladder is blown up with air until the patient feels discomfort. The radiograph is immediately taken without withdrawing the catheter from the bladder. We have in many cases compared the findings on opening the bladder with the results shown by cystogram, and find that in most cases they pretty accurately correspond. If a tumor is pedunculated its pedicle is not shown by cystogram.

Secondary Urethral Tumors—We have seen a good many cases of urethral tumors either accompanying or following bladder tumors. I think we often overlook these small urethral tumors having our eye on the major condition. Whether these are real implantations from the bladder or a retrograde lymphatic invasion I hesitate to say. Most of these urethral implants are of the same structure as the bladder tumor, although I have lately seen a small soft urethral tumor in a patient in whom I had removed an indurated carcinoma from his bladder. I think it safe to consider them as malignant as the bladder tumor.

INDICATIONS FOR RADIUM—1 *Local Removal from Bladder* If the tumor is confined to the bladder it may be suitable for removal by radium. We have removed from the bladder (for various periods of time) all kinds of carcinomata, *viz.*, infiltrating, indurated, extensive, highly malignant †. This naturally does not mean that we have been uniformly successful, far from it. Different tumors react differently to radium.

2 *Hæmaturia*—Radium fairly consistently controls hemorrhage, and may be used for this even if the tumor has gone beyond the bladder.

3 *Retarding the Growth of Tumor*—The question is often asked, "Even if there is no hope of cure, will not radium retard the tumor growth so a patient may live longer and more comfortably?" Undoubtedly this is true now and again. The cases in which radium does this are so few, however, the failures so many, that I believe it unwise to give radium therapy in those cases in which there is no hope of removing the tumor from the bladder.

Reaction of Different Tumors to Radium—Different papillomata showing precisely the same structure microscopically react differently to radium—some are destroyed easily and some resist. The same is true of papillary carcinoma, although as a rule papillary carcinoma seems to be more sensitive to radium than papillomata. Papillary carcinoma can be destroyed by surface radiation (using large doses of screened radium). Indurated carcinomata are best destroyed by the implanting throughout the indurated area small bare tubes of radium into the base of a tumor and leaving them there. These bare tubes are very caustic, and very local in their action, extending over an area of about one cubic centimetre. In using them even with great accuracy it is possible to miss some carcinomatous area. Therefore we use a combination

† The largest infiltrating tumor removed was as large as a hen's egg, had grown through the bladder wall and was adherent to the symphysis. This case is described on p 760.

of the bare tubes (in the depth) and the screened radium (in the surface) in every case of indurated carcinoma

Determination of Method of Radium Treatment—I *Intravesical* Growths confined to and around bladder neck Papillomata Pedunculated papillary carcinoma if pedicle can be reached Infiltrating sessile growths of no more than 2 cm in diameter

II *Suprapubic* Growths other than the above and without metastasis Extensive infiltration of the bladder wall, large and multiple tumors are the indication for section, to which all doubtful cases are submitted

Intravesical Methods By means of a flexible spring holder used through the sheath of the Brown Buerger operative cystoscope a hundred or more millicuries of unscreened radium may be held up against the tumor for the period of half an hour while the tumor is being observed through the cystoscope This may be repeated every two weeks, or less often if the tumor is disappearing satisfactorily If the tumor looks solid or hard, or has a base which looks indurated, then we may treat it by thrusting into its base or the indurated part, a radium needle screened simply by the steel of the needle This needle is also on a flexible spring and is used through the operating cystoscope Needles from fifty to 200 may be used for a period of time up to forty minutes We must remember that in this method the action is local and caustic We have in a similar way implanted small bare tubes of radium into the base of a tumor and left them there For this, bare tubes of 0.5 mc to a square centimetre of tumor are used, and left in place The action here is still more local and more caustic We have used all of these methods and combinations of them in various tumors and by all of them have destroyed small or recurrent carcinomata of the bladder If a tumor is more extensive, if it is papillary in character, if the pathological examination shows pure papilloma, and especially if it be around the bladder neck we often start the treatment by placing into the bladder two tubes of screened radium (6 mm silver, 2 mm rubber) These tubes are inserted through the sheath of a straight cystoscope and tied with a string and left in place for varying periods of hours and then pulled out of the urethra by the attached string As a rule we use two tubes of 50 mc for five or six hours The value of such radiation is first, to see how the tumor reacts to radium, second, to temporarily stop the bleeding to make cystoscopy possible, and third to destroy that portion of the tumor around the internal urethral orifice If the tumor is carcinomatous and large, and we believe from our examination it is confined to the bladder, then we do the open operation described below

Suprapubic Application of Radium in Extensive Carcinoma—Because we were unable to cope with extensive carcinomas of the bladder by the intra-urethral method, in June, 1919, we began to open up the bladders in selected cases and implant radium directly into the carcinoma The technic is as follows

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Gas and oxygen anæsthesia is used. The bladder is prepared previous to operation by washing it out with a 1 : 4000 acriflavine solution, then draining the fluid out of the bladder and blowing the bladder up with air. The patient is placed in Trendelenburg's position. The skin incision is a long one, extending from the symphysis to the umbilicus. The prevesical fascia is cut transversely at the symphysis and dissected back, the bladder being exposed well down its posterior wall. The urachus is cut, and the exposure extends beyond this. The sides of the wound are screened with gauze soaked in acriflavine (1 to 4000) solution. The bladder is gently palpated so the incision may not go

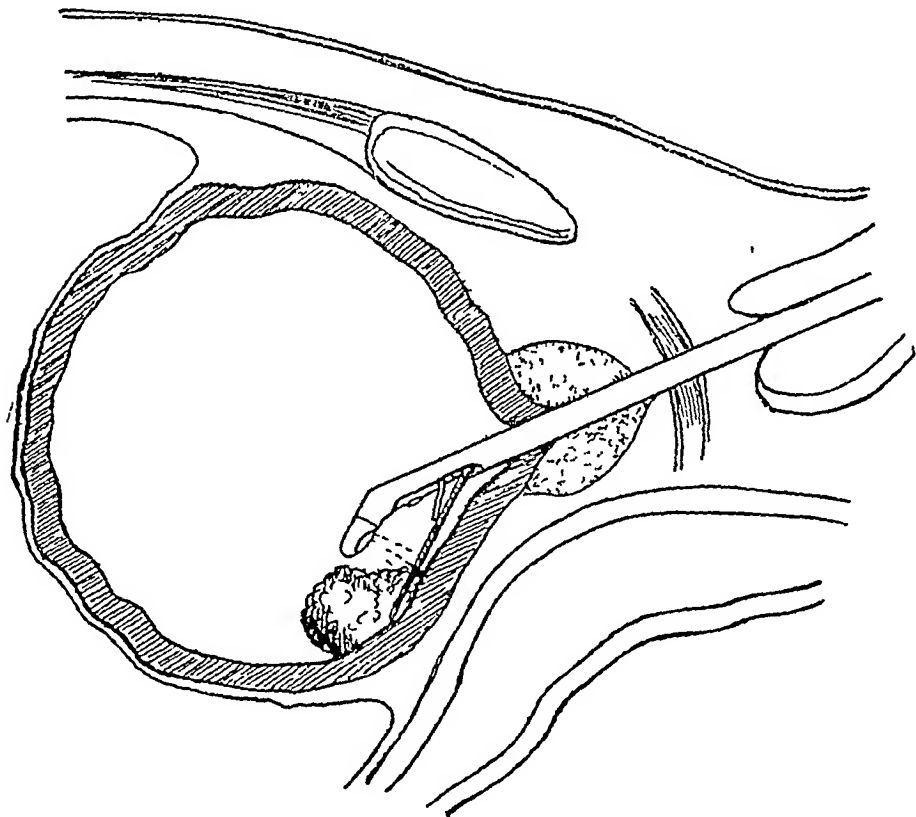


FIG. 2.—Method of burying radium emanation tubes in growth by means of special introducer and the cystoscope

through tumor tissue. Between two clamps the bladder is opened and a three- or four-inch incision is made longitudinally. The cut surface of the bladder is grasped by clamps, the clamps being about one inch apart. The reason for this is that the bladder will otherwise collapse and fall down into the pelvis when retractors are put in it, so making operation impossible. A light is thrown into the bladder and bladder retractors three or four in number are gently placed in the bladder. The retractors which we have used most have been made for us at the Memorial Hospital. They are made of one-eighth-inch steel wire in the form of an open loop. The advantage of these is that the tumor may be seen through the open portion of the retractor, and treated. The tumor being exposed is sponged as little as possible to prevent bleeding and spreading of tumor cells. Alcohol sponges are used. Any pro-

truding portions of the tumor are snared off, using a simple wire snare. If the tumor is flat and not papillary in type, none of it is removed. The reason for snaring off the papillary part is to better expose and treat the base. Indurated parts of the tumor are implanted with radium bare tubes (0.5 mc) by means of a needle, using two of these to the square centimetre. These bare tubes are not put in the normal mucous membrane, but within a quarter of a centimetre of the edge of the tumor.

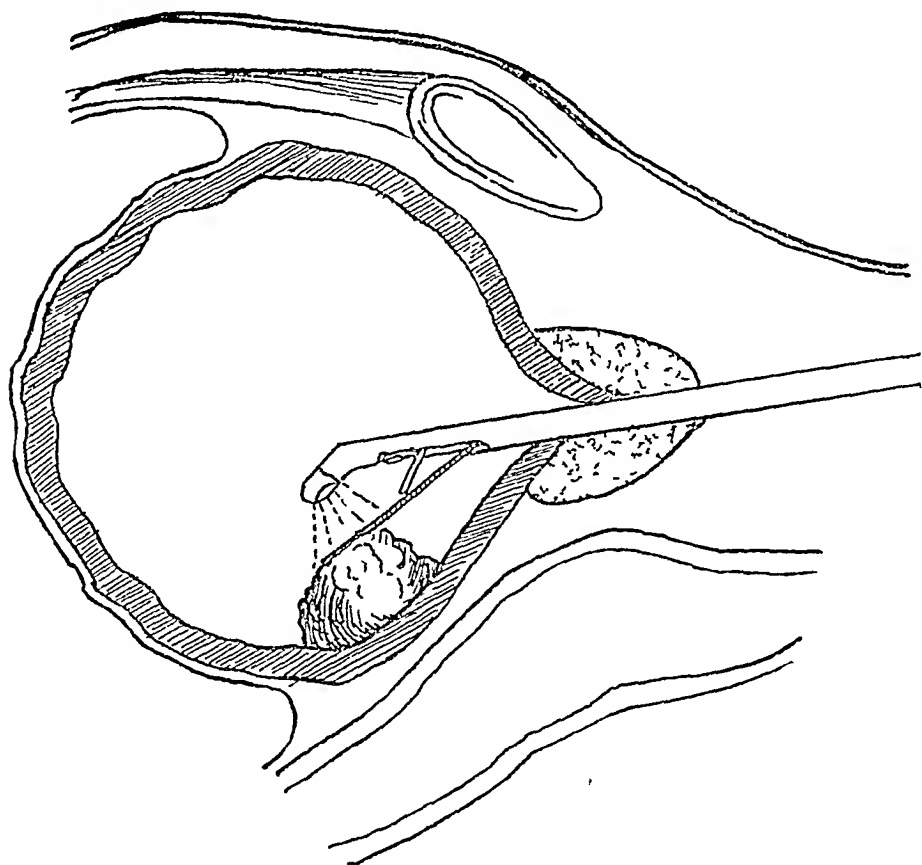


FIG 3 —Surface application of radium emanations to growth under vision by means of special applicator in cystoscope

Finally, surface radiation is accomplished by means of tubes of radium screened by 0.6 mm of silver and two millimetres of rubber placed on the surface of the tumor and held in place either by gauze packing or little hooks on the silver tubes. A string is attached to these tubes, and they are pulled out after an appropriate time. A space $2\frac{1}{2}$ c c in diameter is radiated by two of these tubes placed longitudinally side by side, 1 cm apart. To such an area, 500 or 600 millicurie hours is given. Before placing these tubes in, a can of ether is emptied into the bladder to kill any stray tumor cells. The bladder is closed up with plain catgut, the strings of the radium tubes and the packing exiting through the small opening left in the bladder. The gauze screening in the wound

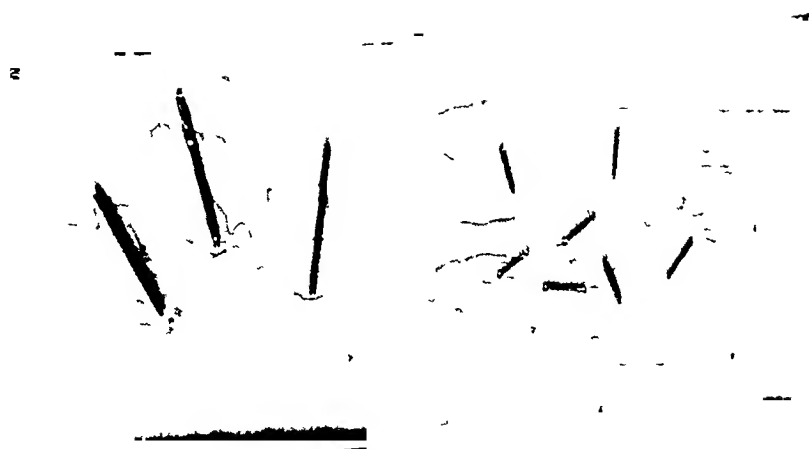


FIG 1 —Tubes of radium emanations The small tubes to right are "bare tubes" used to implant directly into tumors

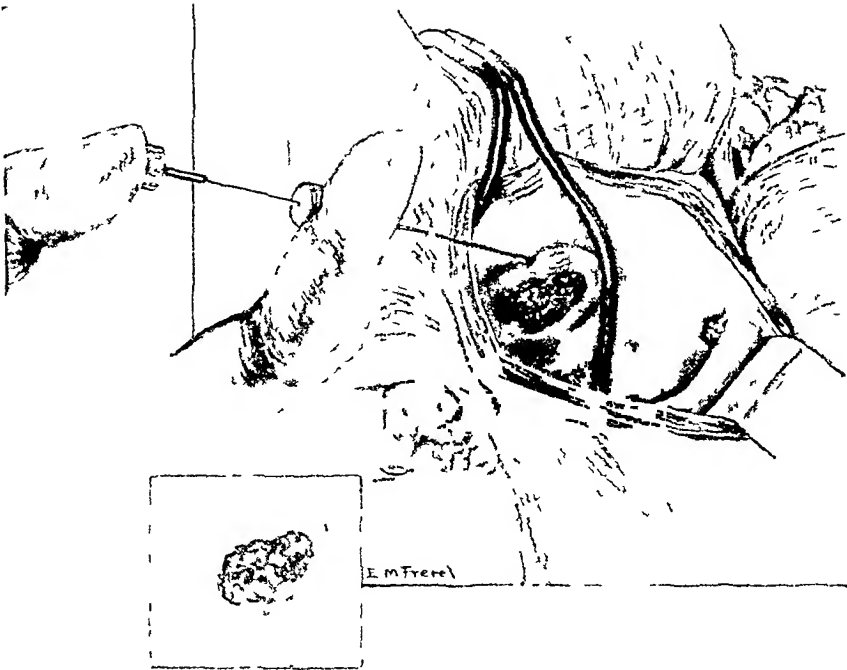


Fig 4 —Burying radium emanation tubes under direct vision after exposure of carcinoma by suprapubic cystotomy

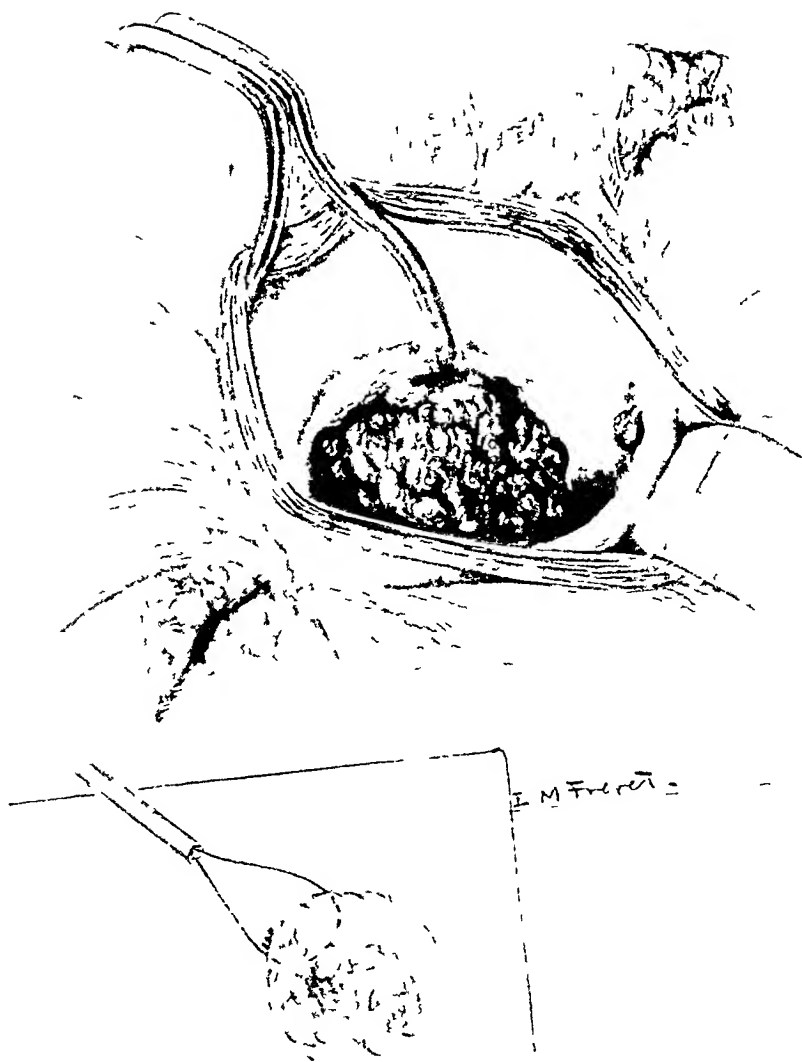


FIG 6 —Use of special retractor in exposing clearly the carcinoma especially its base. Snaring off pedunculated growth preparatory to burying radium emanation tubes in its bore

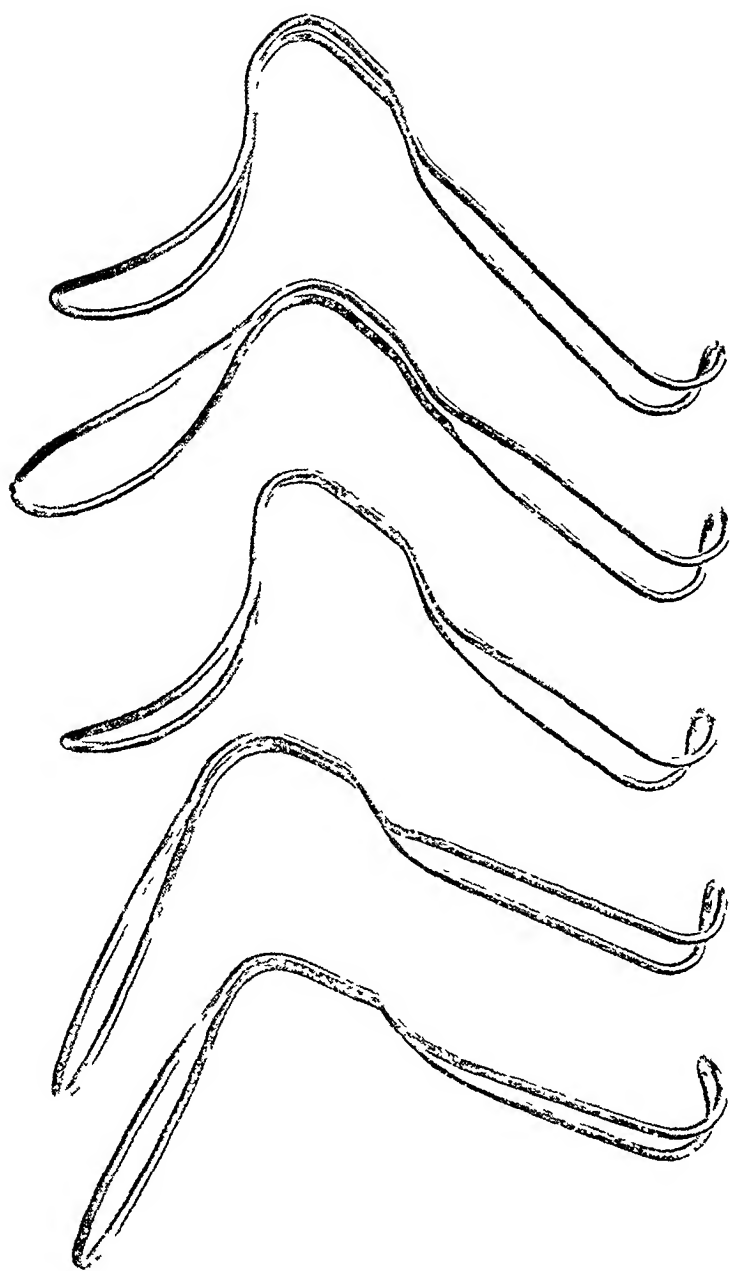


FIG 7—Bladder retractors used in the operative method of burying radium emanation tubes

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is now removed, and ether poured all over the wound. The wound is closed as usual. Two cases operated upon in this manner are here reported to show what can be done in inoperable (aside from total cystectomy) cases.

S. D., male, age thirty-seven. In 1917, nocturnal frequency of urination progressively increasing until he urinated every fifteen minutes. Never hæmaturia.

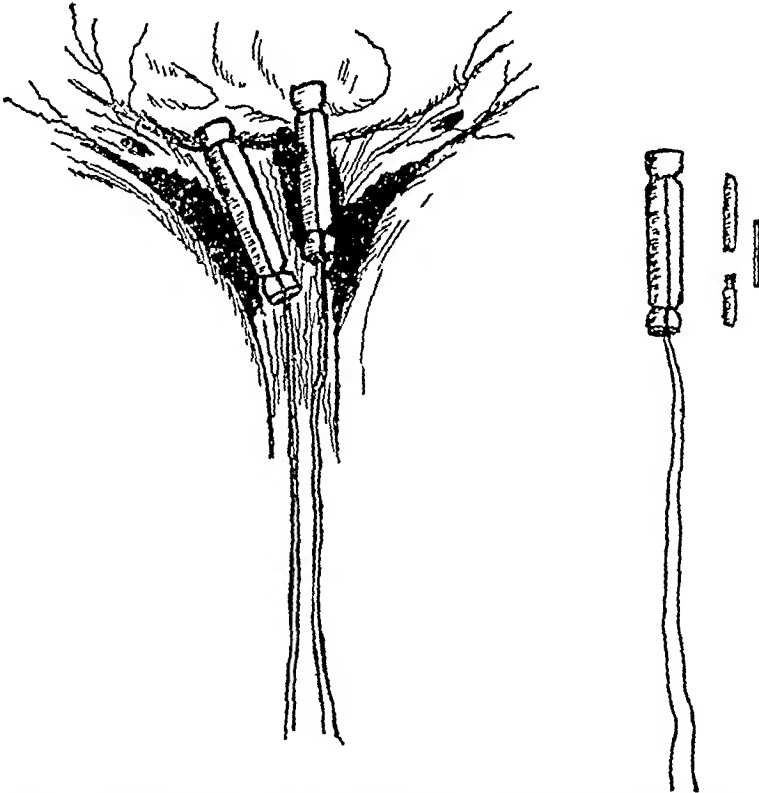


FIG. 5.—Application of radium emanations by means of "bladder tubes" (Radium emanations screened by small silver tubes which are inserted into short pieces of rubber tubing)

November, 1917, a small carcinoma of the bladder was excised. It recurred very rapidly. Shortly after leaving the hospital his frequency was as great as before.

In June, 1919, he came to the Memorial Hospital with complete retention of urine and had to be catheterized. I opened his bladder and found his bladder full of clots and red papillary carcinoma the size of a small orange attached to the left bladder base and lateral wall. The papillary portion of this was cut off with a cautery, and fifteen bare tubes of radium (3 mc. each) were planted in the base of the tumor which was of the size of a silver dollar and which included the opening of the left ureter. A suprapubic tube was left in for a number of days, then removed, the wound healing without trouble. He had burning and frequency for a number of months after operation caused by the radium. Cystoscopy, February 25, 1920, showed a bladder clean of tumor. There was no induration of its bladder base by rectal examination. He had gained thirty-nine pounds in weight and working all the time.

In January, 1921, cystoscopy showed a clean bladder with one or two very small papilloma of his posturethra. These were treated by radium.

H W, male, age sixty-two. A single hæmaturia in January, 1920, then clear urine and again, February, hæmaturia. At this time he was cystoscoped and the diagnosis of "tumor of the bladder" made.

I first saw him in March, 1920. Then he was a well nourished man, had lost no weight, had a nocturnal urinary frequency of two. He passed urine colored with blood. The rectal examination showed slight induration of the middle of the bladder base with a normal prostate. The cystoscopic examination showed a tumor on the right side of his bladder, sloughy on the surface. It was impossible to tell its extent because of the hæmaturia. He gave a history of having had sugar in his urine but his blood sugar was not increased. He was but a fair operative risk. I opened his bladder and found a tumor on the right anterior wall, solid, of the size of a hen's egg. It had grown through the bladder wall and was adherent to the symphysis. We did not cut into the tumor for a specimen, but scraped off a slight portion of the surface which showed on examination mucus and pus. There was no doubt, however, of the clinical diagnosis of "carcinoma." This was the largest carcinoma that we had attempted to remove. We filled the tumor as accurately as was possible with radium tubes of 0.2 cm., two to a cubic centimetre, leaving these in place. The bladder was drained for a long time because I feared the sloughy results from the radium absorption of the tumor. The patient's recovery was uneventful, barring the fact that he had a persistent suprapubic sinus. Three months after my first operation I cut out the bladder sinus and sewed up the bladder. During this operation I searched with my finger the site of the old tumor, and could find nothing abnormal, barring a slight irregularity about 1 cm. square in the surface of the mucous membrane of the bladder. He was last cystoscoped in February, 1921, and his bladder, while slightly hyperæmic over the site of the tumor from the effects of the radium, showed no tumor. He is in the best of health, and has no symptoms except that he gets up once or twice at night to urinate to urinate.

Tables showing the results in both intravesical and suprapubic methods are appended to this article.

Intravesical—We have removed the carcinoma from the bladder in eleven cases by the intravesical application of radium. The longest case has gone four years and four months with the bladder clean of tumor and proved by cystoscopy.

Suprapubic—To January, 1921, we have operated upon twenty-nine cases of carcinoma of the bladder. There were no deaths directly after operation, although one died seven weeks post-operation, and one two months post-operation. Some of these patients showed carcinoma so extensive that no radium treatment was attempted. In ten of the twenty-nine cases the carcinoma was removed from the bladder, the longest case having gone twenty months post-operation with a bladder clean of tumor. Five of the

RADIUM TREATMENT OF CARCINOMA OF THE BLADDER

cases have not been cystoscoped post-operation. The remaining fourteen are dead or doing badly and one has not been traced since he left the hospital. There has been but one implantation of tumor in the operative wound in a case which was operated upon before he came to us—so we can divide the responsibility for this.

Examination of the chart will show how very extensive and inoperable all of the tumors were if we exclude cystectomy. I have never seen any operative statistics that at all compares with those of the above table.

EXTENSIVE CARCINOMA OF BLADDER—RADIUM IMPLANTED THROUGH BLADDER OPENED SUPRAPUBICALLY

No	Name	Age	Date oper	Description of tumor	Pathology	Previous oper	Result
1	V	36	June 1919	Papillary tumor, large as orange, base 5x5 cm, of left bladder base	Papillary infiltrating carcinoma (Ewing)	One	Bladder clean (cystoscopy) 20 months post-op (Sl papilloma of urethra)
2	K	54	Jan 1920	Papillary tumors, indurated base (largest 3x3 cm) all around bladder neck	o	o	Bladder clean (cystoscopy) 9 months post-op
3	W	61	Mar 1920	Solid tumor, ulcerated surface (6x6x6 cm) on anterior wall of bladder, growing through bladder and adherent to pelvis	o	o	Bladder clean (cystoscopy) 12 months post-op
4	W	60	Apr 1920	Pedunculated tumor (small tangenne) covered with incrustations, left bladder wall, indurated base	Papillary carcinoma (Ewing)	o	Bladder clean (cystoscopy) 9 months post-op
5	G	50	Apr 1920	Solid, flat tumor 3x4 cm, within 1 cm of left ureter	Infiltrating carcinoma (Ewing)	o	Recurrence after operation treated intravesically
6	D	33	May 1920	Solid tumor, left wall, 2x4 cm Papillary tumors around bladder neck	Infiltrating carcinoma (Ewing)	o	Bladder clean (cystoscopy) February, 1921
7	T	59	June 1920	Flat, irregular tumor around urethra (treated by radium before oper) Small tumor seen at oper	Infiltrating carcinoma	o	Recurrence after operation Treated intravesically (3 times) Mar, 1920 no tumor Radium slough
8	S	55	July 1920	Papillary tumor, 4x5 cm, of left bladder base Indurated	Papillary carcinoma (Ewing)	o	No tumor 6 months post-op Radium slough (cystoscopy)
9	W	50	Aug 1920	Indurated, ulcerated tumor, 3x3 cm, around sphincter of bladder	Epidermoid carcinoma (Ewing)	o	Bladder clean (cystoscopy) 9 months post-op
10							Bladder clean (cystoscopy) 6 months post-op

Carcinoma of bladder

762

Operated cases

Bladder clean on one or more cystoscopies post-operation

RADIUM TREATMENT OF CARCINOMA OF THE BLADDER

10	R	70	Dec 1920	Indurated, flat, irregular tumor, 3x3 cm, centering in trigone & touching bladder neck	Papilloma (Ewing)	0	Bladder clean (suprapubic observation) 2 months post-op
1	H	48	Sept 1919	Number of hard nodules around bladder base (Scar of radium in bladder neck from pre-op treatment)	Papillary carcinoma (Brooklyn Hospital)	One	Eighteen months post-op has urinary frequency (once at night) No pain Looks and feels entirely well Refuses cystoscopy
2	H	56	Sept 1920	Papillary tumor 6x4 cm posterior to ureter Pedicle infiltrated Base 3x3 cm	Papilloma (Ewing)	0	Recurrence post-op Still treated (March, 1920)
3	B	49	Oct 1920	Multiple hard tumors, bladder base & anterior wall, one 2x3x2 1/4 cm, one 3x1x1 cm	Carcinoma (Brooklyn Hospital)	One	Not cystoscoped post-op
4	M	50	Dec 1920	Indurated ulcerating tumor touching internal urethra 4x3 cm	Squamous infiltrating carcinoma (Ewing)	0	Not cystoscoped post-op
5	R			Solid, rounded, nonpedunculated tumor, indurated base, touching left side trigone, 7x10 cm	Papillary carcinoma (Ewing)	0	Not cystoscoped post-op
1	R	59	July 1919	Whole bladder wall carcinomatous, not treated	0	0	Died 5 months later
2	H	42	July 1919	Extensive indurated carcinoma 10x5x2 cm, probably originating in prostate	Epidermoid carcinoma (Ewing)	0	Died 6 months later
3	R	47	July 1919	Indurated carcinoma around bladder neck, probably primary in prostate	Papilloma (Ewing)	0	Died 14 months later of anuria after pyelotomy to relieve obstruction of lower ureter caused by carcinoma
4	W	41	Aug 1919	Extensive growth of bladder wall, coming from outside bladder (?)	0	0	Died 1 year later
5	C	60	Dec 1919	Entire vault and sides of bladder infiltrated Trigone clear	Infiltrating epidermoid carcinoma (Ewing)	0	Died 3 months later

Carcinoma of bladder
Not cystoscoped since operation

EXTENSIVE CARCINOMA OF BLADDER—RADIUM IMPLANTED THROUGH BLADDER OPENED SUPRAPUBICALLY —(Continued)

	No	Name	Age	Date oper	Description of tumor	Pathology	Previous oper	Result
Carcinoma of bladder Operated cases Patients dead or doing badly or not followed	6	L	38	Dec 1919	Extensive, diffuse papillary tumor of anterior wall	Papillary carcinoma (Ewing)	0	Died at another hospital (3 months post-op) from infection of prevesical space due to sloughing of bladder wall by radium
	7	S	52	Feb 1920	Indurated carcinoma (3x3 cm) around internal urethra	0	0	Died 7 months later
	8	L	60	Apr 1920	Mass size of golf ball, touching internal urethra base, 2x10 cm	Carcinoma (Ewing)	0	Died 2 months later
	9	D	69	Apr 1920	Pedunculated tumor 8x4 cm (base 3x3 cm) attached to trigone	Papillary carcinoma (Ewing)	0	Died of uremia 7 weeks post-op Bilateral pyonephrosis
	10	B	43	Apr 1920	Papillary carcinoma with indurated base (7½x4 cm) touching right ureter	Papillary carcinoma (Ewing)	0	Operated upon twice Now 6 months after 2" Operation has urinary frequency, but is in fair general condition
	11	R	49	Apr 1920	One carcinoma, lateral wall, 5x5 cm x 1 cm (thick), 1 carcinoma left trigone & urethra, 7x1 cm	Infiltrating squamous carcinoma (Ewing)	0	Left hospital in good shape Cannot be traced since
	12	O	50	Apr 1920	Two sloughy tumors, 2½x1 cm & ¾x½ cm	Alveolar carcinoma (Ewing)	Once	Doing badly Implantation in abdominal wound (Mar, 1921)
	13	B	60	May 1920	Flat, indurated carcinoma, 10x7 cm, implant 1x1 cm	Solid carcinoma (Ewing)	0	Died 3 months post-op
	14	E	56	Aug 1920	Sloughy, flat carcinoma, right bladder wall, 3x3 cm	Carcinoma (Ewing)	0	Five per cent sugar in urine at time of operation Died 3 months post-op of perirectal abscess

RADIUM TREATMENT OF CARCINOMA OF THE BLADDER

EXTENSIVE PAPILLOMA OF BLADDER—RADIUM IMPLANTED THROUGH BLADDER OPENED SUPRAPUBICALLY

	No	Name	Age	Date oper	Description of tumor	Pathology	Previous oper	Result
Papilloma bladder Operated cases	1	W	55	May 1920	Firm, red, papillary tumor, large as small orange, base 3x3 cm, external to left ureter. A second small tumor	Papilloma (Ewing)	0	Bladder clean (cystoscopy) 10 months post-op
Bladder clean on Cystoscopy	2	Mc	61	Oct 1920	Tumor large as tangerine (calcareous incrustations), right lateral wall, base 2x2 cm. No induration base	Papilloma (Ewing)	0	Five months post-op no tumor (cystoscopy). Radium slough
	1	W	55	Apr 1920	Bladder filled with papillomata, no induration, of bases	Papilloma (Ewing)	One	Seven months after 1" operation was operated upon 2" time for suprapubic sinus & more papillomata Still treated (March, 1921)
Papilloma bladder	2	C	56	May 1920	Very large papillary tumor 7x7x7 cm, attached to bladder base, posterior to left ureter, base 4x4 cm	Papilloma (Ewing)	0	Reports well 9 months post-op Not cystoscoped post-op
Operated cases not cystoscoped since operation or still treated	3	P	63	June 1920	Entire bladder base & lateral walls covered with papillomata, no induration	Papilloma (Ewing)	0	Six months post-op still papillomata Being treated
	4	K	56	Oct 1920	Pedunculated tumor, 5x4x3 cm anterior to r ureter, no induration	Papilloma (Ewing)		Not cystoscoped post-op
	5	S	48	Dec 1920	Entire lower half bladder filled with papillomata, no induration	Papilloma (Ewing)	0	Not cystoscoped post-op
	1	B	56	Sept 1920	Three papillomata, bladder base, largest 4x4 cm., no induration	Papilloma (Ewing)	0	Died 3 months post-op Pyemia (after pyelotomy for pyonephrosis)

CARCINOMA OF BLADDER TREATED INTRAVESICALLY BY RADIUM CASES IN WHICH TUMOR HAS BEEN REMOVED FROM BLADDER
1916 TO 1920, INCLUSIVE

Case	Age	Sex	Evidence of Carcinoma		Extent	Induration	Urinary frequency D N	Wgt loss	Previous treatment	Radium—Dose— Method	Result
			Cytoscopy	Pathology							
I C A G	69	F	Cauliflower, non-pedunculated, sloughy	Carcinoma (Ewing)	Base 3 cm in diameter over 1 ureter	?	3-4 3-4	0	Fulguration twice	100 mc 8 hrs Bladder tube	Bladder clean 4 yrs 4 mos Cystoscopy
E J S	54	F	Papillary, sloughy in part	Papilloma (Ewing)	All around bladder neck and trigone	Vaginal, 5 cm in diameter	q hr 5-20	?	0	100 mc 8 hrs 2 bladder tubes Repeated twice at 3 mos interval	Bladder clean 1 yr Cystoscopy Well (letter) 4 yrs
L M	70	F	Papillary red tumor of bladder base	Carcinoma (Ewing)	Multiple large one on trigone	Vaginal, small area	Frequent & pain	0	Fulguration 2 years	200 mc 7 hrs 2 bladder tubes	Bladder clean 2 yrs then recurrence (rapid growth) Removed by radium 1 yr Radium burn
J A H	62	M	Rapidly growing, flat, ulcerated	Carcinoma (Ewing)	Small, operable near ureter	0	2-3	0	Fulguration once	180 mc 6 hrs 2 bladder tubes Repeated in 4 mos	Bladder clean 4 yrs (cystoscopy) (Kidney no function on side corresponding to tumor)
H F R	68	M	Sloughy papillary tumor	Papillary carcinoma (Ewing)	Extensive, bladder neck	?	q hr q hr	17 lb	0	100 mc 8 hrs 2 bladder tubes Repeated 6 mos later for recurrence	1st, bladder clean 3 mos 2nd, bladder clean 1 1/2 yrs Well 2 1/2 yrs (letter) Bladder clean once (cystoscopy)
A T V W	59	F	Papillary tumor some slough, left trigone	Papillary carcinoma (Ewing)	2x2 cm	?	2-3 2-3	0	0	100 mc 6 1/2 hrs 2 bladder tubes Repeated 6 mos later	Bladder clean once (cystoscopy)
F H P	63	M	2 tumors, 1 necrotic, 1 red	0	Around bladder neck	0	q 3 hr 2	0	0	70 mc 4 hrs 2 bladder tubes	Bladder clean 4 mos (Cystoscopy) Well 2 yrs (letter)

RADIUM TREATMENT OF CARCINOMA OF THE BLADDER

G	64	F	Tumor, flat, ulcerating, lateral wall	Epidermoid carcinoma (Ewing)	2x3 cm	o	q 2 hr q 2 hr	o	o	100 mc 5 hrs 2 bladder tubes (2 of 0.5) 100 mc 6 hrs 2 bladder tubes	No tumor 8 mos later (cystoscopy) Radium burn No tumor 8 mos later (cystoscopy)
W	50	F	Small, ulcerating, flat, back of ureter	Epidermoid carcinoma (Ewing)	3x3 cm	o	o	o	o		
H	50	M	Red, smooth, rounded tumor near sphincter	Questionable if Carcinoma	3x3x2 cm	o	o	o	o	Base tubes (0.5) through cystoscope	No tumor 1 yr later (cystoscopy)
S	53	M	Multiple, sloughy, around bladder neck	Carcinoma (?) (Ewing)	Multiple, largest 1x1 1/2x3 cm	o	?	o	o	100 mc 5 hrs 2 bladder tubes	No tumor 2 mos later (cystoscopy)

PAPILLOMA OF BLADDER

C	60	M	Bladder filled with grape-like masses, recurring post-op	Papillary (Mandlebaum)	Bladder vault (?) full	o	?	o	o	2 tubes 50, 8 hrs	Sl tumor 3 yrs 8 mos later Treated No tumor 3 mos later
Z	42	F	Multiple, red tumors around sphincter	Papillary (Ewing)	Multiple one 3x3 cm	o	o	o	o	100 mc 8 hrs 1 bladder tube	Recurrence 3 yrs later Treated No tumor 3 mos later Died hemorrhage
R	63	F	Multiple, red papilloma gone	Papillary (Ewing)	5x5x4 cm	o	o	o	o	90 mc 7 hrs 2 bladder tubes	Reported no papilloma 1 yr later (cystoscopy)
O.D	74	F	Red, papillary growth behind ureter	o	5x5x5 cm	o	o	o	o	100 mc 8 hrs 2 bladder tubes Subsequent fulguration	No tumor 9 mos later (cystoscopy)

HÆMOSTASIS IN SUPRAPUBIC PROSTATECTOMY BY THE METHOD OF THE "LOST TAMPON"

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At the present time it is generally agreed among the majority of surgeons that suprapubic prostatectomy is the operation of choice in prostatic hypertrophy. The argument of a smaller group of surgeons for the perineal operation is based on its smaller mortality other things being equal. I shall not go into details as to the comparative merit of the two methods, but shall confine my remarks to the operative procedures which are necessary to make the suprapubic operation as safe against possible complications as an operation of this magnitude can be made. Cabot¹ says "The high operation is, I believe, far more efficient and for this reason we might be willing to accept a higher risk, but not until it appears that we have reduced the mortality to the lowest possible figure compatible with efficient work. There are three factors which contribute most importantly to the mortality of the operation and to those I would direct your attention. These are the anæsthetics, the shock, entirely apart from bleeding, and the bleeding itself. It has, of course, been generally recognized that the control of bleeding was an important factor in the success of operation and yet I do not think that recognition has been as complete as the situation requires."

The complications which are apt to mar the results of suprapubic prostatectomy are, in order of their frequency, hemorrhage, shock, uræmia, sepsis. Shock, uræmia and sepsis we have learned to avoid, in the majority of cases which are at all considered operable, by the two-stage operation and local anæsthesia. It is the question of hæmostasis which is still a source of anxiety to the surgeon, and the many different methods advocated to deal with postoperative hemorrhage show, that up to the present this great danger is not adequately met.

The difficulty of reliable hæmostasis in prostatic hypertrophy lies in the peculiar anatomical conditions. After enucleation of the gland a large bleeding cavity is left which freely communicates with the bladder, more or less filled with urine. It is the inability of the surgeon to keep the bed of the prostate dry which is responsible for the severe postoperative hemorrhages, adding a certain avoidable percentage to the mortality.

The source of the bleeding can be the arteries and veins in the torn mucous membrane of the urethra and bladder. These vessels, however, are rarely large and of no great importance and can easily be dealt with by suture or the application of clamps. The dangerous hemorrhages arise from the bed of the prostate itself.

Let us consider for a moment what happens when we enucleate the prostatic gland. In order to understand this properly we have to take into consideration a few anatomical points. The prostatic tissue is surrounded by a thin but fairly resistant tunica propria consisting of connective tissue and smooth muscle fibres. This tunica is the only structure which deserves the name "prostatic capsule." External to this thin capsule lies the pelvic connective tissue which in front and on both sides of the gland make up the superior pelvic fascia. Posteriorly the pelvic fascia forms what is known as

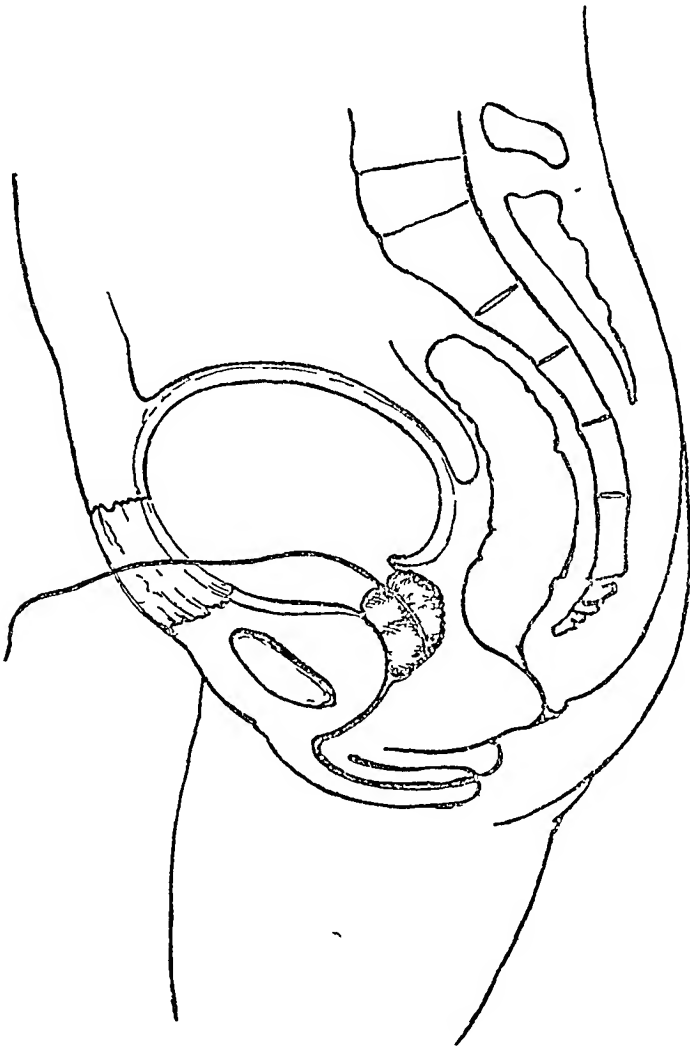


FIG. 1.—Tampon inserted into bed of prostate

Denonvillier's fascia. Between Denonvillier's fascia and the capsula propria of the prostate there are situated only very small veins which empty into the hemorrhoidal venous plexus. In front, however, and on the lateral aspects of the prostate there are placed between the capsula propria and the superior pelvic fascia the very large and important venous plexus of Santorini (in front of the gland) and vesical venous plexus (laterally to the gland). The wall of the wound cavity consists mainly of the original gland-

dular masses of the prostate proper which has been compressed by the hypertrophy of accessory prostatic glandular tissue which lies scattered in the neighborhood of the internal orifice of the bladder and throughout the whole part of the prostatic urethra. Thus it is seen that what we call prostatic capsule in the surgical sense is in reality compressed lateral lobe of the prostate gland. In performing suprapubic prostatectomy, therefore, we remove these accessory hypertrophied masses, whereas the true prostatic tissue is left in the wall of the wound cavity. These findings of Lehndorf² have been confirmed by Freudenberg,³ who made his interesting anatomical studies on patients who had died from the operation. The hypertrophy of the prostate was confined exclusively to that part of the gland which lies between the internal orifice of the urethra and the mouth of the ductus deferentes.

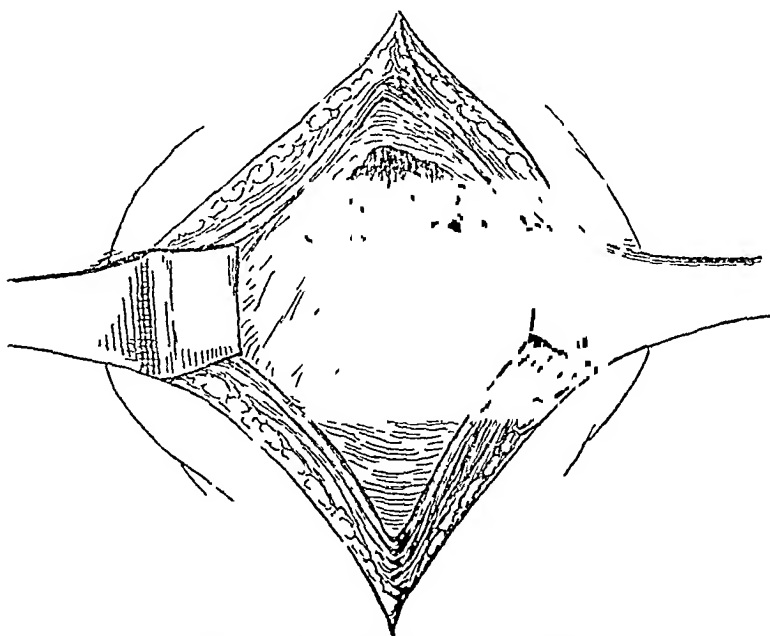


FIG. 2.—View of prostatic bed from above

Ordinarily, therefore, the bleeding comes mostly from the mucous membrane of the urethra and the bladder and the compressed prostate tissue in the wall of the cavity. The hemorrhage from these tissues is usually not excessive. The dangerous hemorrhages must originate from injuries of the plexus Santorini and vesical plexus which are only protected by the thin, although fairly resistant capsula propria, it can easily be understood that injuries of the venous plexus are possible, especially in difficult enucleations. This would also explain our experience that severe hemorrhages occur not in all cases of suprapubic prostatectomy, but only in a certain percentage of cases in which these venous structures have been inadvertently injured.

Methods of Control of Hemorrhage—Three different procedures have been recommended

HÆMOSTASIS IN SUPRAPUBIC PROSTATECTOMY

- 1 Packing of the prostatic bed by gauze tampon
- 2 Continuous irrigation with hot saline or mildly antiseptic fluids
- 3 Mechanical contrivances as the Hagner and Sores¹ bag

The method which suggests itself naturally is the gauze tampon on account of its simplicity and ever-readiness. However, it was found that in spite of careful packing hemorrhage could not be controlled and surgeons therefore looked around for other reliable means

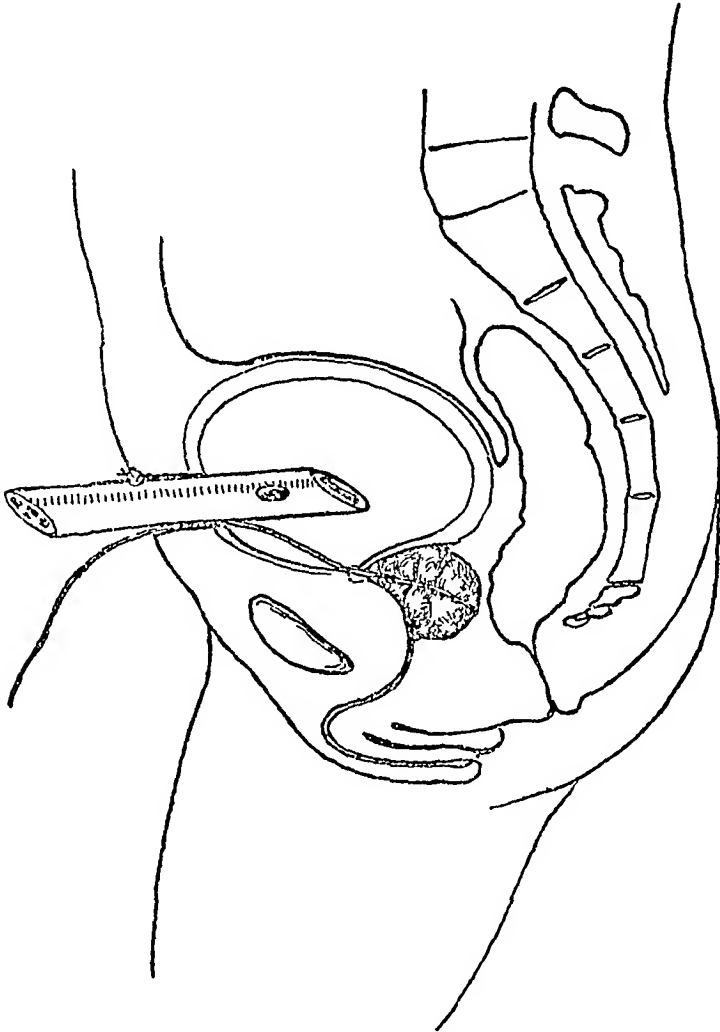


FIG 3 —Bladder closed over tampon

Suter,⁴ in speaking of hemorrhage, remarks that none of the various methods in use against it constitute a guarantee

Squier⁵ packs cavity with strip of gauze which is led out of the bladder through a large drainage tube

Beer⁶ also packs with a strip of gauze attached to a heavy silk thread which is passed through the bladder drainage tube. Thompson recommends against the danger of bleeding internal administrations of chloride of calcium two days before operation, a procedure which Augier criticizes on account of

the danger of thrombosis and embolism caused by the increased coagulability of the blood

Freeman⁷ employs a strip of iodoform gauze, or gauze soaked in some styptic material. The end of the gauze is retained in the grasp of a pair of blunt forceps. He leaves the clamp in the bladder, its ends projecting from the wound. He exerts pressure upon the clamp by passing an ordinary rubber bandage around the patient's body beneath the pelvis and over the notch between the locked handles.

Barringer⁸ publishes practically the same method a few years later and cites as disadvantages of the method (1) Patient keeps wet, frequent changes of dressings are necessary (2) Packing in prostate cavity causes certain amount of pain. Continued irrigation of hot fluids either saline or some

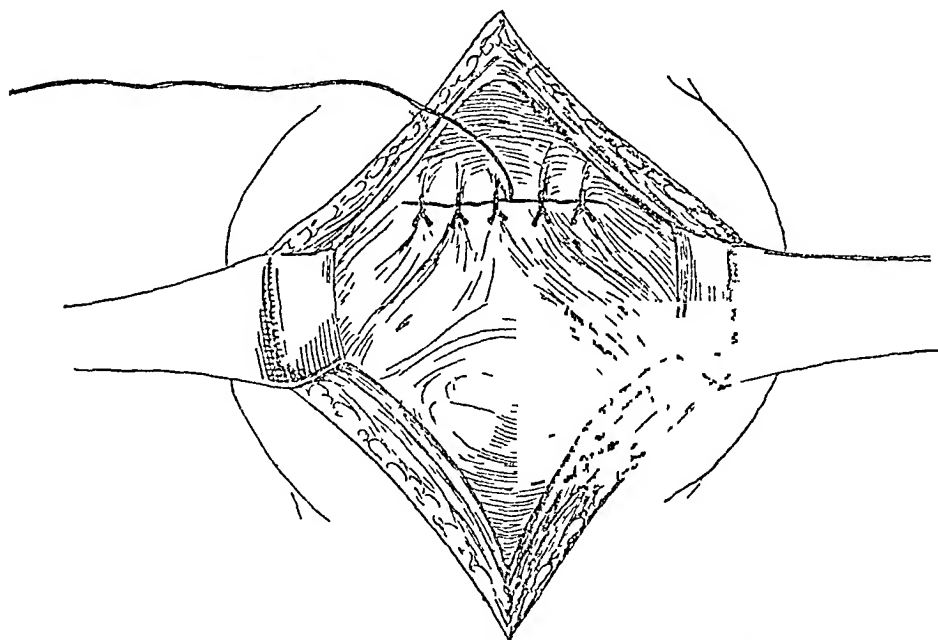


FIG 4—View from above prostatic cavity closed by sutures silk string led out through epicystotomy wound

mildly antiseptic lotion has been often tried. I myself have used it in a few cases, only to experience in one case a rather profuse bleeding one hour after operation, necessitating reopening of the bladder and packing.

Freyer⁹ recommends bladder irrigation with hot boric lotion (temperature 110° F) through the catheter still *in situ* for the purpose of removing clots and further to control bleeding. He advises, however, that this process should not be continued for more than two or three minutes, as he finds from experience that these irrigations not infrequently promote bleeding, instead of diminishing it, if the irrigations be continued too long. Hagner has recommended a rubber bag which is introduced into the cavity of the prostata and is kept distended by air. A similar contrivance has been used by Sores¹⁰ in which the bag is kept distended by mercury. The objection to these

mechanical contrivances is that they easily get out of order, are cumbersome and not always at hand

The best means after all to control hemorrhage is the simplest and one which does not need special instruments, *i e*, packing with gauze. Why is it then that this means so universally successful in other regions of the body is so singularly unreliable in controlling hemorrhage in the prostatic cavity?

The principal reason for this in my opinion is the failure of the gauze tampon to stick to the tissues for any length of time on account of the continuous soaking of the same by urine flowing down into the bladder. This fact has been recognized by Freeman and Barringer (although they do not specifically mention it), who try to overcome this soaking loose of the gauze by continuous pressure exerted upon the tampon by a clamp or a sponge-holder. Deaver¹¹ and Kammerer¹² were the first to employ sutures of the intravesical wound edges over the tampon.

Deaver says "It is necessary * * * to so perform this operation that fatal hemorrhage and sepsis will be rare events, instead of the extraordinarily common ones which they are at the present time if the mortality of prostatectomy is to be reduced * * * and in the event of hemorrhage it is often difficult to apply gauze packing. This is then the one certain way to control hemorrhage after prostatectomy. Distensible bags and similar playthings are effective only in cases in which there is no bleeding." In another article he advises the following: Before introducing the gauze into the prostatic bed carry a continuous suture through the upper margin of the lateral walls of the cavity, the free ends of the sutures to be tied tightly after the gauze projects through the incision in the abdominal wall. Kammerer uses a similar procedure. After placing the tampon into the bed of the prostata, the opening of the prostatic cavity is partly closed by a transverse suture of strong plain catgut, passing through the entire thickness of the bladder wall and the capsule of the enucleated prostata. The upper end of the opening is not sutured. Through this opening the tampon is passed into the bladder and further through the suprapubic opening into the gauze dressing. The sutures were placed without tying them, the tampon was then introduced and was of such a size that when the sutures were tied a certain amount of compression of the tampon would take place. A Freyer tube was put into the bladder above the projecting end of the tampon and wound was closed. The tube and the tampon were removed on the third day.

Author's Method—After the prostate has been removed, the edges of the wound are caught up with a few Allis' clamps and thereby kept apart. A strip of iodoform gauze is tightly packed into the cavity until all its recesses are well filled. The projecting part of the tampon is cut off. If the hemorrhage is controlled this tampon is removed and used as a pattern for the size of the final tampon. The final tampon is secured by a stout silk ligature fastened around its middle and its whole mass is introduced into the cavity. Before the tampon is definitely placed, the prostatic cavity is once more care-

fully cleaned of all blood coagula which may have accumulated After introduction of the gauze pack the wound edges are tightly sutured with strong plain catgut over the tampon, the silk thread being let out between two sutures and through the suprapubic wound The prostatic cavity is thus completely shut off from the interior of the bladder A drainage tube is fastened in the bladder in such a way that it does not touch the bladder fundus, and the bladder and the abdominal wound tightly closed around it

The prevesical space is also drained by a small cigarette drain For placing the sutures I use the so-called "boomerang needle holder" constructed by Young, which is the best instrument I know for the application of deep-seated sutures After three or four days the sutures have become loose and the tampon can be withdrawn by pulling on the silk string, the drainage tube being removed at the same time

I have used this method of hæmostasis by "the lost tampon method" for all my prostatic work in the last six years and have had no postoperative hemorrhage, neither have I seen any untoward symptoms which could be attributed to the method

The main advantage of my method I see in the ability to entirely close off the prostatic bed from the bladder, thereby preventing the tampon from being soaked loose by the accumulating urine Another advantage is that the urine which is always more or less infected does not come in contact with the fresh wound cavity The urine does not stagnate in the recesses and infection is less apt to occur

In closing this article, I came across a short reference in the *Centralblatt f Chirg* No 40, 1920, p 234, in which Rubritius at a meeting of the *freie Vereinigung der Chirurgen Wiens*, March 11, 1920, states that for controlling hemorrhages he uses "a lost tampon" with string attached

Whether he closes the cavity by suture is not mentioned

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DEFECTS OF THE PATELLAR BORDER

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AND

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Many surgeons during the late war must have been greatly puzzled, as was the senior author of this paper, by not infrequent cases of obscure disability of the knee joint. The cases as I saw them gave no history of injury, or if they did it was of such an indefinite character as to produce the impression that it was the result of suggestion. The disability was nearly always unilateral. The knee was swollen but not particularly hot and not red. The swelling was not great but the resultant stiffness and pain were quite enough to render the patient unfit for military duties for a varying time. A curious feature of the cases was that the swelling appeared infrequently and almost always after a route march. No case presented itself as having occurred in consequence of games after retreat. It was this fact which made me suspicious until I became convinced by the number and by the actual physical appearance of the joint area that there was really some disability of obscure origin. None of the radiograms taken of those cases falling under my care showed clear signs of any anomalous or pathological condition, but at that time I was unaware of the condition which we are about to discuss in this paper so that I cannot say that a careful search with this special feature in mind would still have resulted in negative findings. It is certainly true that the disability is a real one and that patients with this disability are not class "A" men. On my return to civil life I determined to investigate anew the vast amount of material in the Hamann Museum with the especial purpose of discovering, if possible, some adequate cause of the disability. Since the history of the cases failed to give indubitable evidence of trauma and the condition did not as a rule result from ordinary activities in a young man's life, it seemed necessary to look for some slight lesion or some anomaly, as the result of the presence of which, repeated slight trauma regularly applied, such as that due to the continuous and somewhat monotonous action of the knee in a route march, might light up the condition. In the routine examination of skeletons accruing to the museum during my absence with the troops I noted the patellar anomaly herein described, and the suggestion formed itself in my mind that there was a possible cause of the condition observed in the army. The material was therefore turned over for investigation to the junior author (W C McC) who has worked it up into suitable shape for publication. The senior author (T W T) however is solely responsible for the form of presentation. While the work was already under way the important article by Salmond² appeared. This

confirmed the impression given by the purely anatomical study here that clinical condition and anatomical appearance should be correlated

HISTORICAL REVIEW

Emargination of the patella was first described by Kempson in 1902¹ as a common variation in which there is a depression in the upper portion of the outer margin of the bone. The depression varies from a very small and insignificant one to a large area involving the patella quite deeply and extending from half an inch from the median vertical line of the bone to half way down the outer margin. Upper and lower extremities may be marked by spicules or sharp bony points. The condition is equally present in ancient and modern bones. The area of defect corresponds with the area of attachment of the vastus lateralis muscle.

In 1904 Wright reverted to the question of emargination in consequence of discovering a case of "accessory patella."³ The anomalous patella which Wright describes consists of a larger medial part and two lateral portions, upper and lower. Together the two lateral "accessory patellæ" include the greater part of the lateral border of the bone. Two cases of emargination are also figured and it is suggested that both emargination and accessory patella are variants of one anomaly resulting from more than one center of ossification for the patellar area. Possibly the accessory centers are not in the quadriceps tendon but in the ilio-tibial tract of fascia lata.

Salmond in 1919 as the result of his observations in the service came to the conclusion that there is a fissured fracture of the patella of not infrequent occurrence, not conforming with the usual type, and with an indefinite history of injury.²

The fracture described by Salmond is a fissure situated at the outer border or at the external superior angle of the bone in the neighborhood of the vastus lateralis insertion. It is sometimes a slight crack with no displacement, but in extreme cases the whole border of the patella is detached with "callus thrown out to bridge the gap." The patient never came to the X-ray department with a diagnosis of possible patellar fracture but always for an inflammatory condition. Sometimes more than one fragment is found. History of trauma is vague and cannot be depended upon. Nevertheless Salmond considers the cases to be of traumatic origin. They may be unilateral or bilateral.

It will be necessary, as a result of the views expressed by the authors quoted above, to examine very carefully the patellæ under investigation so that a decision may be made as to how far the condition should be considered an anomaly and how far trauma may be responsible.

TYPES OF EMARGINATION

Very many patellæ show merely the slightest indication of a difference between the upper and outer part of the circumference and the remainder of the margin. A typical example of this condition is shown in Fig 1, which is a photograph of the patellæ of No 775, male, colored, age thirty-seven

years As with all photographs illustrating this article the patellæ are shown from behind and at two-thirds natural size unless otherwise stated This variation is so often met with that it would be impossible to give any idea of its frequency In any case its frequency would not be important the interesting fact is its occurrence at all There is apparently no reason why the site of insertion of the vastus lateralis should differ from that of any other of the muscle quadriceps group At the age of thirty-seven slight lipping occurs as a regular age change at the patellar margin This lipping has no relation whatever to so-called rheumatism or arthritis One can be quite dogmatic upon this point although the full evidence for the assertion has not yet been published This subject forms the body of a future publication Such lipping as occurs in this specimen does not involve the emarginate area, a circumstance which must give the observer food for thought

The condition found in Fig 2 is still more striking This illustrates the appearance of patellæ from Cadaver 831, male, white, age forty-seven years The lipping in this specimen is much more pronounced than that of ten years earlier, but though it forms an outstanding rim to the remainder of the margin there is little or no encroachment upon the area of emargination It is extremely doubtful if there existed any emargination previous to the occurrence of lipping Indeed we are inclined to believe that this is a case of spurious emargination due entirely to the presence of lipping If this be the case it does not detract from the interest of the specimen but rather enhances it for it indicates that there is some reason why lipping does not take place at all readily at this site

Fig 3, showing the patellæ from No 795, male, colored, age fifty-four years, at first seems plainly pathological The lipping so pronounced elsewhere however does not involve the outer margin of the bones, and adjacent to the area of typical emargination is a pathological exuberant bone growth The facts that this is bilateral and almost symmetrical, and that it involves just this particular portion of the patellar surface, suggest that there is some cause for the picking out of the area, although actually it may be nothing more than a remarkable coincidence We have observed in other parts of the skeleton that areas which for some special reason are particularly vulnerable are picked out by a pathological lesion with remarkable accuracy and we are strongly of the opinion that this case should be so interpreted

Whatever difference of opinion there may be about the last specimen the pair now to be presented permits of no uncertainty This is No 494, male, white, age forty-two years It is represented in dorsal view (Fig 4) ventral view (Fig 5), and by transillumination (Fig 6) Figs 4 and 5 are two-thirds natural size, Fig 6 is of actual size This is a very important case and illustrates beautifully one type of the condition which specially interested Salmond There is a fissure almost but not entirely separating the upper and lateral portion of the patella from the remainder of the bone The condition is bilateral and almost symmetrical On the left side the area might be considered to have been separated by violence and reunited On the

right side the fissure is not complete. The central view (Fig 5) would bear the same interpretation. There are however certain facts which reduce the possibility of violence as causative to vanishing point. The condition is bilateral. There is little likelihood that both patellæ would be so symmetrically damaged by a single act of violence. It is equally unlikely that two similar accidents at different times would happen to one individual. The left patella which shows the greater separation has a relatively great breadth, which is characteristic of bones exhibiting this anomaly and could not be accounted the union of a fracture. Both bones are very thin in the area of the "fissure," as shown by the manner in which the light has penetrated in Fig 6. This method of photographing bones by transillumination was first suggested to us by Dr W W Graves of Saint Louis. In this case it picks out beautifully the slight amount of lipping which has taken place at forty-two years. Neither Fig 4 nor Fig 5 shows the lipping with anything like the clearness exhibited in Fig 6. It is rather unlikely that such a fracture, did it occur, would heal by bony union, in view of the tendency for the ventral periosteum and tendinous fibers to slip in between the separated fragments. The intrinsic evidence is therefore quite against fracture and in favor of anomaly.

Occasionally in place of or in addition to emargination there is found either on one side only or symmetrically a "punched" out depression in the dorsal (articular) patellar surface. A bilateral instance of this condition is shown in Fig 7, which represents the patellæ of No 425, male, white, age about thirty-six years. These holes extend well into the body of the bone. Their margins are rounded and not elevated. The walls are smooth and sloping and the base is coarsely cancellous. There is no evidence about them of tuberculosis or of inflammatory reaction. Otherwise the knee-joint surfaces are normal and there is nothing in our record of the case to point to a possible pathological origin. The holes are undoubtedly anomalies of patellar development.

As if to insure our acceptance of the statement made in the preceding paragraph, namely that patellar depressions are a form of anomaly closely linked with patellar subdivision, we are able to present Fig 8. This shows the patellæ of No 309, male, white, age sixty-six. Lipping occurs on both bones but is minimal in the area of emargination. Patellar subdivision is present only upon the right. In it typical broadening of the bone takes place and the upper and outer part of the patella is missing. That there was a completely separated piece of the bone now missing is clearly indicated by the specimen itself. The surface which lay in contact with the accessory portion shows a smoothed cancellous appearance which we have come to associate only with a bony surface resulting from fracture with non-union or congenital separation. There is considerable lipping on the ventral margin and this again indicates that there has been in fact a separate ossification. Now on the dorsal margin, in a position corresponding with the location of the pits in No 425, and visible in Fig 8, is a conical pit burrowing into the substance of the bone and similar in every way except in size with the pits of

PLATE I—Defects of the Patellar Border

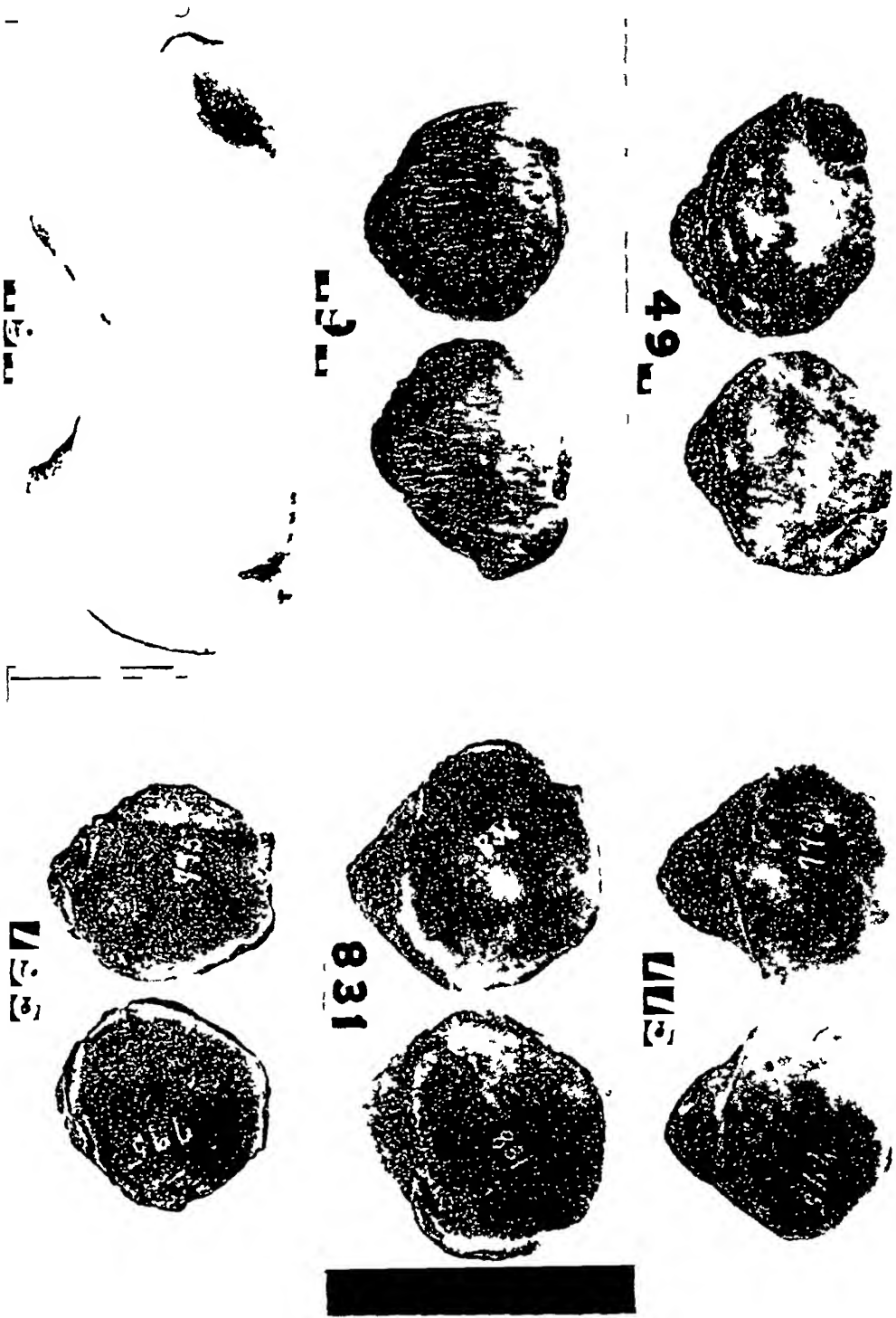


FIG 4, 5, 6

FIG 1, 2, 3

PLATE II—Defects of the Patellar Border

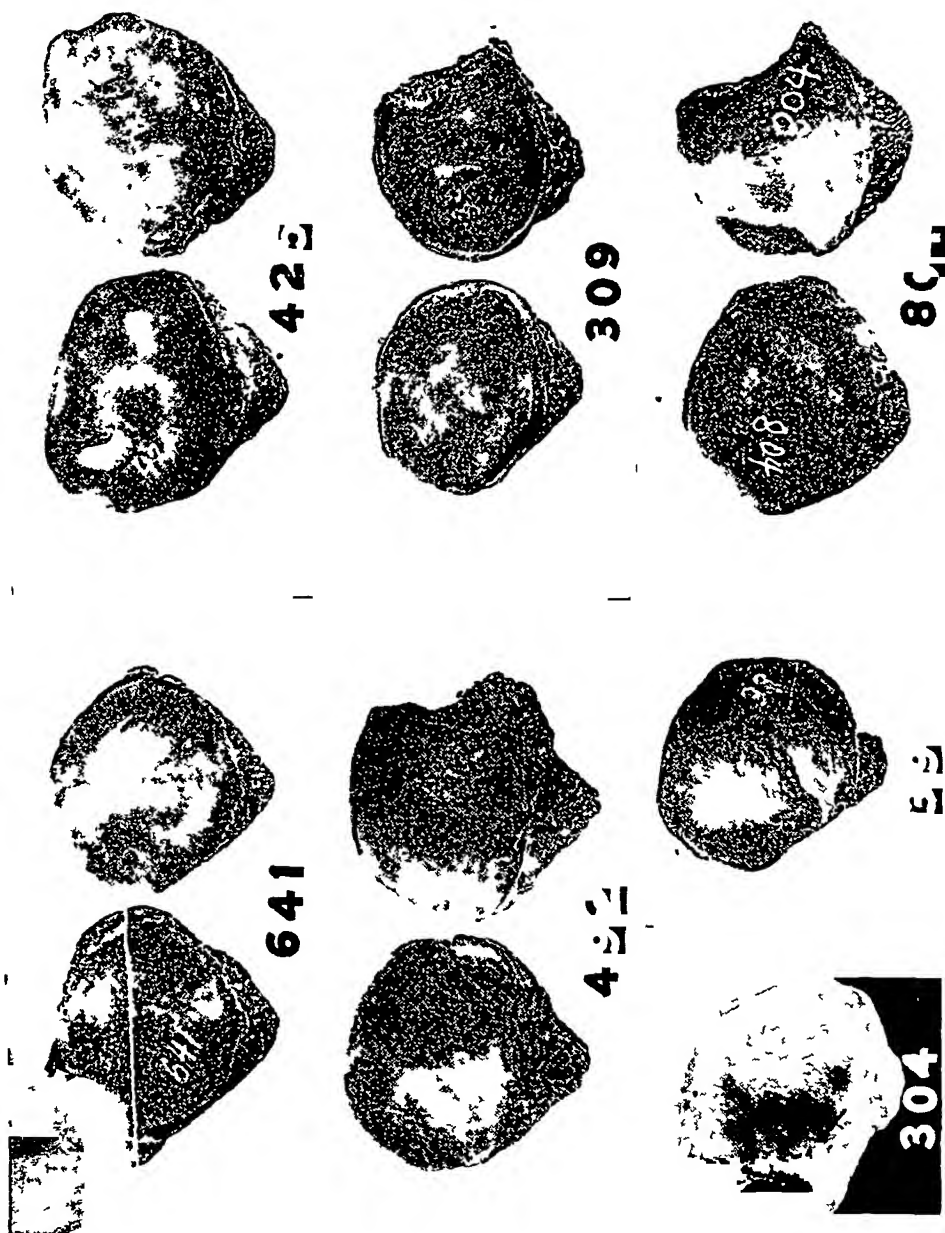


FIG 7, 8 9

FIG. 12

FIG 10 11, 13

PLATE III—Defects of the Patella Border



32



641

804

492

FIG 15

FIG 14

DEFECTS OF THE PATELLAR BORDER

No 425 From these and other similar examples we are convinced that patellar pits and patellar subdivisions are phases of one anomaly

A very similar case but without the patellar pit is No 804, male, white, age forty-three years, shown in Fig 9 Because of its age there is scarcely any lipping of these bones and in this respect the specimen differs markedly from No 309 There is in addition no lipping of the emarginate area This again is probably an age characteristic The emarginate surface shows that the accessory ossicle has been entirely separate The left bone shows slight emargination

Fig 10 illustrates another very marked example of emargination It is a photograph of No 641, male, white, age fifty-three years There is the usual transverse broadening of the bone The spicules at the extremities of the area are exceedingly well marked in this specimen The accessory ossicle is preserved in this case but unfortunately it was omitted from the photograph The condition though marked is unilateral The emarginate surface shows that there has been complete separation of the accessory bone but no pseudo-articular surface is developed This specimen is practically a duplicate of one described by Kempson¹

No 492 (Fig 11) is a particularly interesting specimen It comes from a male white cadaver fifty years of age There is a well marked emarginate area on the right bone, and partly encircling, but extending below it, there is a fine hair line on the print which is the mark of a second separation of original bony centers Although it is faintly marked one has no doubt that this bone is one similar to that described by Wright as having two accessory ossifications Turning to the left patella we note a similar hair line demarcating the lower and more medial part of the bone From this occurrence we should infer that original ossification of the patella may be from several centers distributed somewhat irregularly in occasional individuals

As illustrative of the various sites of separate centers of ossification we include Fig 12, the left patella from No 39, male, white, age forty-seven Examination of this photograph will show that the lowest part, to which is attached the patellar ligament, has ossified separately here The mark of the union of the two parts, slight as it is, shows on both dorsal and ventral aspects

Fig 13, the left patella from No 304, male, white, age seventy years, shows a marked lipping of the emarginate area consequent upon age but equally indicative of complete separation of the accessory ossicle

Fig 14, the patellæ from Cadaver No 32, male, colored, age about forty-two years, is quite important, for in it we note the ossification of a slighter grade of emargination which is bilateral with a typical "fissure" indicating a separate ossification center in a very usual position It might be doubted why we have associated the slighter grade of emargination with extensive "fragmentation" of the patella This specimen gives our reason We believe that all these conditions which we have just described are simply phases

of one type of anomaly, namely that in which the patella is not ossified from a single center but from two or more

The last illustration (Fig 15) shows the emarginate areas on specimens Nos 641, 804, 492, respectively, in order from left to right. In all it will be observed that the typical cancellous surface has been smoothed over by a more or less complete compact shell, as always occurs when two portions of bone, originally or normally one, are separate and sufficiently loosely attached to each other to permit of slight movement.

DISCUSSION OF FINDINGS

In the foregoing pages we have presented a consecutive and fairly complete series of patellæ showing what we believe to be various phases of an anomaly of patellar ossification. In the course of the description we have adduced evidence against the assumption of violence or indeed any degree of trauma as a causative agent. The conditions which we have featured have been noted by previous workers both anatomically and radiographically. We have not attempted to give a complete historical record, believing the multiplication of descriptions of single instances of one phase alone to be of little value. We have preferred to give a comprehensive survey of the phase first hand as the volume of material accessible to us in this laboratory permits us to do.

If however our contention as to origin be correct there should be found in children from three to five years of age some definite evidence in favor of our position. We have examined the patellæ of the six skeletons of approximately the proper age in this museum but have not had the good fortune to find any which show more than one center of ossification in the patella. Nevertheless there must be such cases and undoubtedly they will be found in time.

The patellæ of twenty-three full-term fetuses were dissected out in order to examine the cartilaginous predecessor of the bone for evidence regarding a future subdivision of the patella. The most striking result of this investigation was the discovery that in forty of the forty-six specimens a portion of the cartilage was found to differ from the remainder in that its color was lighter and upon the surface, though not throughout the thickness of the patella, it was definitely demarcated from the rest of the cartilage. This special area lies in the typical site of emargination, namely at the upper and outer portion of the patellar margin. Under the microscope this seemingly separate portion was found to be entirely superficial. Hence although its presence is suggestive one can draw no definite conclusions regarding patella ossification from it.

Admittedly the part of our investigation which relates to the child and the fetus is devoid of the result for which we had been led to hope by the variations in adult condition. Nevertheless we are convinced that we are dealing with an anomaly rather than with a fracture. For this view we have given our reasons on previous pages relating to specific cases.

Apart from the intrinsic evidence of each specimen against trauma as

DEFECTS OF THE PATELLAR BORDER

the provoking cause there is the fact that emargination occurs twice as frequently on both sides as it occurs on one side only, judging from our material. As to the age incidence we do not obtain among the 682 skeletons which have been examined for this condition any convincing evidence that it occurs more frequently as age increases. It is not a very frequent anomaly, but occurs on one or both sides in three per cent of our cadavers. That all the pronounced cases are found in males is no indication of a sex distinction for our male skeletons are about seven times as numerous as our female skeletons. It is quite possible to examine 100 female skeletons and not find one instance of an anomaly which has a frequency of only three per cent.

ASSEMBLED RESULTS

We may now briefly summarize our observations in the following manner:

There is a condition of the patella occurring in about three per cent of human beings characterized by more or less marked defect of the upper and outer part of the bone.

Certain minor defects which are ill marked and show up best when lipping of the patella becomes a prominent feature are not included in the estimate of three per cent. These occur much more frequently.

The area in which patellar defect occurs presents certain differences from the remainder of the bone even in the cartilaginous condition. In the adult lipping is exceedingly slow to make its appearance in this area. Pathological conditions of the articular surface are prone to present themselves in this area.

The area to which reference has just been made is known as the area of emargination. It is associated with the attachment of the vastus lateralis tendon.

Patellar emargination may occur as a very slight defect. There may be a much larger defect in the bone which may or may not be occupied by a separate ossification. Again, there may be incomplete separation of the patellar portions.

Associating with or occurring in place of patellar defect there may be a condition of deep pitting of the articular surface.

No indication of recent or old callus formation is present on any of our specimens, whether of complete or incomplete separation of the patellar portions.

No indications of inflammatory processes occur in relation to either patellar defect or excavation.

Lipping of the margins of the emarginate area occurs with age, this must not be mistaken for callus formation.

A history of trauma is not given by the cases in which patellar defect is found.

The condition occurs on both sides twice as frequently as upon one side.

There is no convincing evidence that the condition occurs more frequently with increasing age.

We have been able to present all phases of the development of the

condition, although the results of our investigations upon children are unsatisfactory

There is no doubt that the patella sometimes ossifies from separate centers in the vertical axis. We have presented specimens showing the probability of other centers of ossification in individual instances.

As the result of the findings just summarized we believe that the condition is an anomaly and not a fracture.

RELATION TO TRAUMA

In the previous section we have reiterated our conviction that the so-called fissured fractures of the upper and outer part of the patella are merely variants of the condition known as patellar defect or emargination, and are not due to trauma so slight that the patient is unable to give a clear account of its occurrence. We do not thereby mean to infer that trauma has no relation to the appearance of symptoms. Far from that we are in entire accord with Salmond in holding that symptoms occur after some slight and often unrecognized strain or injury. It is apparent that a knee joint, the patella of which is not a single bone, but consists of two or even more separate and possibly slightly mobile ossifications, cannot be considered a normal joint. It is conceivable that such a joint will be susceptible to insults which would produce no appreciable effect upon a normal joint, and it is evident that these insults will be more likely to occur in repeated movements of the limb more or less unaccustomed, such as military drill or route marches. Further, the effect of strains upon a composite patella of the type herein considered will be much more pronounced than upon a normal bone. Their effects will persist longer and be more liable to recur. Although we insist that the condition is a true anomaly we admit the condition is a disability the gravity of which will depend upon the precise phase of the anomaly exhibited. Symptoms of disorder may never appear until some slight and possibly unrecognized trauma evokes them.

SUMMARY

For a summary of the results of this investigation the reader is referred to the two last sections of the paper.

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ON THE TRAUMATOLOGY OF THE SESAMOID STRUCTURES

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THIS article has been preceded by an anatomical study of the sesamoid structures published in the *Journal of Anatomy*, London, July, 1921. As there are several debated points about the traumatic pathology of the sesamoids, mainly due to the reading and interpretation of skiagrams, it was advantageous that any clinical data should be given after a preparatory anatomical research based on radiologic findings. The results of these anatomical, morphologic and radiologic investigations may be summarized, as follows. The metacarpo-phalangeal sesamoids of the pollex were seen in 98.2 per cent, those of the index and auricular in 64.2 per cent and 44.6 per cent, and those of the middle and ring fingers in 5.3 per cent and 7.1 per cent of cases. The interphalangeal sesamoids of the pollex were seen in 22.3 per cent. No other interphalangeal sesamoids were seen radiographically.

An (?) "epilunatum," a "pretrapezium," and the "os triquetrum secundarium" or the "ulnare antebrachii," and a possible "naviculare bipartitum" were seen in 1 per cent of the carpal cases. One hundred and twelve skiagrams of hands and wrists were examined.

The metatarso-phalangeal sesamoids of the hallux are a constant feature of the foot. The metatarso-phalangeal sesamoids of the fifth toe appeared in 10 per cent of cases, and those of the fourth and second toes in 2 per cent and 1 per cent. The interphalangeal sesamoids of the hallux were present in 5 per cent and those of the second and third toe in 1 per cent of cases. The inner or tibial metatarso-phalangeal sesamoid of the hallux was congenitally divided in a transverse direction in 4 per cent of cases. In one case (1 per cent) there was an extra intersesamoid of the hallux (Fig. 1). The outer or peroneal metatarsal phalangeal sesamoid of the hallux was not seen congenitally divided.

Among the tarsal formations the "os trigonum" was seen in 7 per cent, the "os peroneale" in 5 per cent, the trochlear process of the talus in 5 per cent, the "os tibiale" in 2 per cent, the secondary "os calcis" and an intertalo-scaphoid in 1 per cent (Fig. 2). The secondary cuboid, intermetatarsium, intercuneiform, division of the first cuneiform and the problematic "os vesalii" were not seen in any of the 100 skiagrams of feet examined.

All these bones have an evolution identical with that of any other cartilaginous bone. The reason why the "os peroneale," for instance, appears in some skiagrams too far behind the calcaneo-cuboid line depends on the degree and starting point of its ossification at the postero-inferior part of the cartilaginous nucleus (Fig. 3). The great development of the hallux sesamoids is an anatomical feature of the biped deambulation of men.

Irregularities of ossification of the tarsal navicular bone, which is morphologically a very complex structure of the human tarsus, might assist in explaining the pathology of the so-called Kohler's syndrome. The "os tib-

ale externum" appears constantly in the tarsus of the sea-lion, for instance

I have examined 100 skiagrams of the foot, dissected several feet, and studied histologically the "os peroneale"

The outer gastrocnemius sesamoid was found in ten out of fifty skiagrams of the knee. In 100 X-ray plates of the patella I could find no evidence of "patella bipartita"

The so-called bicipital, tricipital, and supinator brevis sesamoids of the upper limb were not seen in any case, and the same can be said of the lower limb, so-called psoas, gluteus, and gracilis sesamoids. Any sesamoid may have one, two or more centres of ossification. A congenital division of these structures is shown by a regular line and no marked diastasis of the fragments, or by a concavo-convex line of separation. The bilaterality of the condition is confirmatory, but not essential for the diagnosis of congenital division. The peroneal metatarso-phalangeal sesamoid of the hallux very rarely appears normally divided, and the facility with which it normally assumes a position in the digital cleft on following abduction of the hallux, explains the rarity of its trauma. These points have a great bearing on the common diagnosis of the so-called fractures of the hallux tibial metatarso-phalangeal sesamoid and the rarity of cases reported of fracture of the hallux fibular sesamoid.

I have divided these structures into *Supernumerary bones* and *sesamoids*. The first are formed by those bones that have a well-defined morphological ancestry, such as the gastrocnemii formation so common among dogs, foxes, otters, monkeys ("cynocephalus anubis"), etc. The latter are the fibrous, cartilaginous or osseous elements seen in the human limbs in the neighborhood of the joints, excluding pathological findings, such as the traumatic formations improperly called bicipital, tricipital, etc., sesamoids.

The kinetic theory alone does not suffice to explain the existence of the sesamoids. Pressure, traction and friction are not the essential causes in the formation of these structures. Any articulation of the types of enarthrosis or condylarthrosis requires the presence of intra- or periarticular elements of a sesamoid nature, which are perpetuated by phylogeny and enlarged in size by motion.

Fracture of the sesamoid bones was observed much earlier in animals than in man. Youatt, in 1866, quotes two interesting cases of fractures of the sesamoids in horses. He describes one case as follows: "Fuller was galloping steadily and not rapidly a horse of his own when the animal suddenly fell as if he had been shot." He verified that both the perforans and perforatus tendons of the near foreleg were completely ruptured, just when they pass over the sesamoid bone, which was fractured in a transverse direction. The sesamoid of the off leg was fractured in the same direction, but the tendons were entire."

Schunke (1901) appears to have been the first author to describe a case of sesamoid fracture in man. Since Schunke's case was published, several others have been reported, and latterly with comparative frequency. A

FIG 1 —Illustrates a third intersesamoid of the metatarso-phalangeal joint of the hallux. This is neither a case of longitudinal division nor a traumatic diastasis

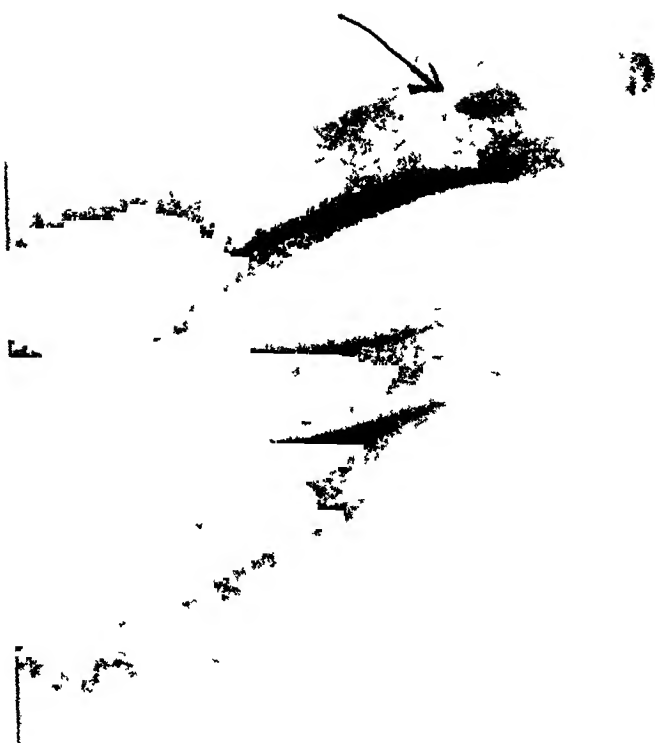


FIG 2 —Shows a well formed os tibial and the supra-trochlear process of the talus. Both were symplomatic

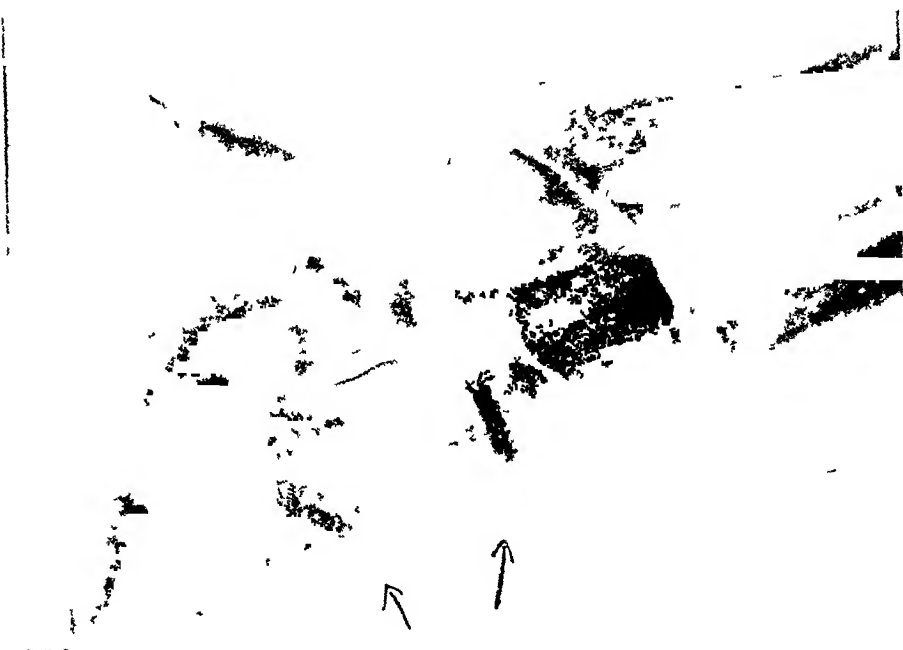




FIG 3 --Shows the ossification of the os peroneal at the postero inferior part of its cartilagenous nucleus and a rudimentary secondary os calcis



FIG. 4 —Shows fracture of the neck of the 2nd, 3rd, 4th and 5th metatarsals, a dislocation of the metatarso phalangeal joint of the big toe and a T shaped fracture of the flular sesamoid of the hallux. Note the wide gap between the three fragments of the broken sesamoid.

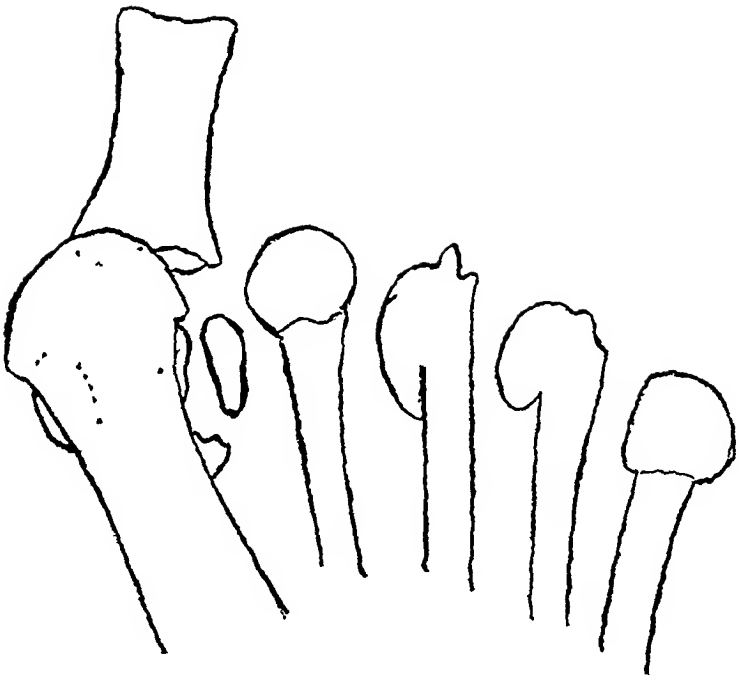


FIG 5—Diagram demonstrating the preceding Fig 4. Note wide gap between the fragments of the fibular sesamoid fracture and a slight degree of luxation inwards of the tibial sesamoid.

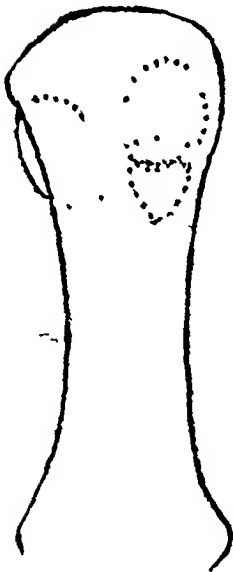


FIG 6—Diagram showing a fracture of the tibial sesamoid of the hallux. Diagnosis based on the width of the gap of the fracture.

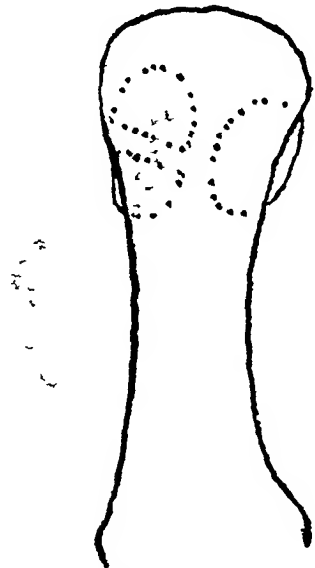


FIG 7—Fracture of the tibial sesamoid of the hallux. The direction of the fracture is slightly oblique. In this last case there is only very slight degree of luxation of the fibular sesamoid.

THE TRAUMATOLOGY OF THE SESAMOID STRUCTURES

list of some cases of fracture of the hallux metatarso-phalangeal sesamoid is given herewith

AUTHOR	YEAR	CASES	BONE
Schunke	1901	1	Tibial sesamoid
Marx	1904	1	Tibial sesamoid
Polak	1906	1	Fibular
Muskat	1906	1	Tibial
Momburg	1907	2	Tibial
Stumme	1908	2	Tibial
Igelstein	1908	1	Fibular
Morian	1909	5	Tibial
Morian	1909	1	Fibular
Morton	1910	1	Tibial
Painter	1910	1	Both bones
Royer	1911	1	Tibial
Muller	1912	1	Tibial
Speed	1914	4	Tibial
Speed	1914	1	Fibular
Boardman	1915	1	Tibial
Eiken	1916	1	Tibial
Eiken (refers to)	1916	4	Tibial
Orr	1918	1	Tibial
Hall-Edwards	1918	1	Tibial
Scales	1918	1	Tibial
Bizarro	1918	2	Tibial
Carreras	1919	4	Tibial
Mayet	1920	1	Tibial
Serafini	1920	2	Tibial
Mouchet	1920	1	Tibial
Colleschi	1920	1	Tibial
Herman-Johnson	1920	1	Tibial
Freiberg	1920	12	Tibial
Freiberg	1920	2	Fibular
Bizarro	1920	1	Fibular

This table shows the rarity of the involvement of the fibular sesamoid of the hallux. A full analysis of all the above cases is unnecessary, as it has already been supplied, with reference to some, in the papers by Muller, Boardman, Orr and Serafini. Sir Robert Jones has had in his clinic several cases of fracture of the sesamoids of the hallux, and this fact "has often been associated with hallux valgus where symptoms had followed injuries"

Among my three cases the most recent is of particular interest

CASE I—Man, twenty-three years of age, engine driver. In August, 1920, while sitting on a motor-lorry his right foot got pushed in, as the result of a collision. The toes became suddenly hyperextended. The foot became swollen and tender, preventing him from walking, and he had ever since to go about on crutches.

I examined him on October 15, 1920, and found that the first phalanx of the hallux was dislocated upwards. The X-ray examination (Figs 4 and 5) revealed fracture of the neck of the second, third, fourth and fifth metatarsals and a *T-shaped fracture of the fibular metatarso-phalangeal sesamoid of the hallux*. The fragments were widely separated and irregularly placed. The skiagram of the left foot revealed nothing abnormal.

On October 19, 1920, I performed the reduction of the dislocated phalanx.

through a dorsal incision. It was difficult to maintain the phalanx in place. The extensor tendon was lengthened and the foot placed in plaster.

At the beginning of January the patient was walking comfortably and wearing an ordinary boot. Six months after the injury there was no radiologic evidence of bony union of the sesamoid fragments. The physiological recovery was complete and the movements of the metatarso-phalangeal joint of the hallux only slightly limited in the flexion.

CASE II—Man, twenty-nine, laborer. Stepped left foot against a stone in June, 1918. I examined him in August, 1918, on account of pain and some local swelling confined to the inner side of the foot, at the level of the first metatarsal head. The X-ray examination revealed a *transverse division of the hallux tibial metatarso-phalangeal sesamoid of the left foot* (Fig 6), with some separation between the two fragments. The anterior bit of bone is larger than the posterior. The skiagram of the right foot was normal.

After massage and wearing transverse metatarsal bar across the sole of the left boot, this patient was able to walk without difficulty within a month.

CASE III—Woman, forty-nine years. She complained for some time of marked pain in right foot. There was no local swelling and no special location of the pain. The skiagram revealed a *transverse division of the hallux tibial metatarso-phalangeal sesamoid of the right foot* (Fig 7) and some bony changes in both feet like rheumatoid arthritis. There was a small spur in the second metatarsal head. She remembered having knocked her right foot, sometime previously, against the curb of the footsteps. Massage and a transverse bar improved her condition.

The *mechanism of fracture* of the hallux sesamoids is not quite clear. Stumme and Morian have proved experimentally in the cadaver that forcible dorsiflexion and abduction of the toe may give rise to a fracture of the tibial sesamoid of the hallux. Marked comminution may be obtained by hammering the foot with or without boots on.

Case I seems to demonstrate conclusively that marked extension of the toes, which in this case went so far as to produce a dorsal dislocation of the phalanx, may cause fracture of the sesamoid. This corresponds to the direct type of fracture as occurring in the case of the patella. The main feature of such a case is the overextension of the muscles, tendons and sesamoid structures against the metatarsal head or compression between it and the traumatic agent.

In this case there was conclusive evidence of direct injury, elsewhere in the foot, since the metatarsal heads were fractured. Naturally it is more difficult, in the case of the foot, to say which mechanism is directly responsible for the fracture, and this renders the discrimination between direct and indirect fractures very indefinite.

Speed summarizes the causes of fractures of the sesamoids of the hallux as follows: (1) Direct violence due to the fall of heavy objects on the foot, (2) squeezing the hallux between heavy masses, (3) falls from a height on to the foot, (4) sudden increase in weight-bearing force when carrying heavy weights.

In fact, it will be noticed that the fractures of the sesamoids of the hallux usually occur in such circumstances as the following: Jumping on the feet, stepping off stairs and causing extreme toe hyperextension, a fall from a

height, hitting the foot against a rock while swimming, as dancing and skating accidents, catching the foot in a hole, falls of heavy objects on the foot, etc

The great majority of the above mechanisms are of the direct type of violence. The indirect type of fracture arises only when the toe is caught by the trauma, which produces a sudden marked hyperextension of the phalanx and followed by a tightening up of the adjacent tendinous structures. The reason why the fibular sesamoid of the hallux is so seldom injured appears to depend on the facility with which it escapes into the interval between the metatarsal heads, on following abduction of the toe, and thus avoids impact against the hard substance of the metatarsal extremity. This I have shown and discussed in the anatomical section of this article. The same reasoning does not apply in the case of the tibial sesamoid of the hallux. Moreover, the frequency with which this bone appears to be normally divided, renders the possibility of mistake greater than is supposed by some authors. These points were brought forward in the anatomical part of this paper.

Putti, Stumme and others have stated that the history of the case, the X-ray examination of the opposite foot, and the line of the supposed division are matters to be studied before a diagnosis of fracture should be given.

The fragments in congenital cases usually show a transverse line of division, which in some rarer cases is oblique or even longitudinal, and the lesion is not uncommonly present in both feet. These facts have been well illustrated in the first part of this article published in the *Journal of Anatomy*. On the other hand, the unilaterality and the irregularity of the line or lines of division cannot be held to exclude the possibility of congenital division—Momburg, Scott and others have insisted on this.

The appearance of tooth-like projections in the line of division is a character to be looked for in the case of larger bones, and practically cannot be recognized in the case of the sesamoids. It appears that the *degree of separation of the fragments, the unilaterality and the irregularity of the line of division*, when they are all present, are the most important guides in the diagnosis of fracture. In fact, I venture to suggest that some of the cases given in the above list were not real fractures, for the reason that some did not show sufficiently marked separation of the fragments.

On the other hand, too much stress should not be laid on *pain* in the diagnosis of fracture. In fact, it is difficult to see how a mere transverse division of a tibial sesamoid, without any separation of the fragments, should cause much pain. Momburg expressed the opinion that pain is due to the trauma producing dislocation of the fragments and to a secondary inflammation in the joint. Igelstein, on the other hand, thinks that pain follows pressure on nerves by the fragments. The cause of pain in congenital cases of division is very difficult to explain, and it probably has an origin similar so that of tenderness in cases of Morton's metatarsalgia, which has been, by Sir Robert Jones, explained as due to "treading upon the nerves."

In some individuals the pain appears to be associated with a cause which has been overlooked tendency to weakness of the foot, spurs, etc. In Case III it was possible to find a fracture of the tibial metatarso-phalangeal sesamoid of the hallux associated with a metatarsal spur. It is said that in some cases the pain has been relieved by the removal of the sesamoid.

Serafini states, in a special chapter of his paper on inflammatory lesions of the sesamoids, that when neither fracture nor luxation of these bones is seen, the metatarsalgia is possibly due to periostitis of the sesamoid, the periostitis being the result of frequent and repeated trauma, wearing tight boots, etc.

In some cases the injury to the sesamoid is associated with an injury to the neighboring bones, and this has been considered by some authors to be the best proof of the fracture being of the direct type.

The two metatarso-phalangeal sesamoids of the hallux are very seldom fractured in the same foot. Painter's case is unique, as both sesamoids were fractured transversely. The injury occurred in a man sixty-six years old, who injured his foot while walking over the rocks.

Clinically in fracture of the sesamoids alone, without any apparent injury to the neighboring structure, there is a history of trauma, followed by some local swelling, pain and tenderness on walking, pressing the metatarsal head, or moving the toe. A few cases have been reported in which there was no trauma, and the diagnosis of fracture was made on the ground that the lesion was unilateral. It is to be remembered that congenital divisions are often unilateral, as cases of fracture in both feet may occur.

Swelling is only of diagnostic importance if it is well localized around the metatarsal head and appears to persist for some time after the injury.

The pain is in some cases spontaneous and has the same features as in any other fracture and is very marked when associated, as frequently happens, with fracture of the phalanges or metatarsals.

The tenderness can be elicited by pressing on the ball of the foot or making passive movements of abduction and adduction of the toe.

Crepitation has been felt in some rare cases.

The plantar X-ray examination of both feet is essential, and on the fractured side a lateral view should also be taken. This is more conveniently done with the foot placed in a slanting position of 90 degrees, in order to avoid the projection of the toes on the plate. This position shows very clearly, in some cases, the interval between the articular surfaces of the sesamoids and metatarsal head. The image of the sesamoids usually overlaps.

The *treatment* of fracture of the hallux sesamoids is divided into non-operative and operative. The majority of authors are of opinion that rest at first, plaster, and later massage are the best measures of treatment. I found that a *metatarsal bar* in the sole of the boot, as recommended by Sir Robert Jones, is an essential item in the treatment of these cases. Any associated condition should be carefully dealt with.

Operative treatment consisting in removal of the fractured bone is advo-

THE TRAUMATOLOGY OF THE SESAMOID STRUCTURES

cated by some, when troublesome symptoms persist for some time after the injury, or, immediately after the trauma as a prophylactic measure. Some surgeons have even removed congenitally divided sesamoids for localized pain over the metatarsal head.

Cases of *luxation* of the hallux sesamoids are occasionally referred to in the literature (Gillette)

Sir W. Thorburn, in 1896, refers to a case of a man sixty-one years of age, a laborer, who suffered from pain in the foot, after the fall of a heavy weight. He removed the lump which was followed by the relief of the pain. Little denied that the pain in this case was due to the apparent luxation of the sesamoid, which he always found to be present in hallux valgus. The big toe appears, in the X-ray positive, to be abducted as Little maintained.

Perlmann, in 1904, describes a luxation of the proximal phalanx of the hallux, fracture of the head of the second metatarsal and luxation of the tibial sesamoid to the outer side of the metatarsal head. This case has several points of resemblance with my Case I, and shows a rare occurrence of luxation of the tibial sesamoid of the hallux. This case did well with massage and rest.

Karschulin, in 1906, reports a case of luxation of the metacarpo-phalangeal articulation and of the sesamoids of the hallux.

On the other hand, Hancock, 1873, refers to resection of the hallux sesamoids by Hilton on two occasions. He adds, that ankylosis was obtained in the diseased joints. Sir R. Jones has had one case "in which a portion of the metatarsal head of the hallux had been fractured and was ankylosed to a crushed sesamoid."

Sesamoidectomy for the treatment of hallux valgus has been mentioned by Twinn on a discussion following the reading of Freiberg's paper on injury of the hallux sesamoids.

Occasionally the supernumerary bones of the foot may be the underlying cause of swelling and pain after a trauma, or, more rarely without any traumatic history. Elmslie, Painter, Malone and others refer to cases in which the os tibiale externum was the apparent cause of some disability which disappeared after its removal. The same has been reported (Stropeni, etc.) of almost every supernumerary bone of the tarsal range. In the anatomical part of this paper I have referred to several cases of supernumerary tarsal bones in which there were no symptoms, including a very advanced case of trochlear process of the talus, being the case able to wear boots and comfortably walk long distances. I referred already to a case of fracture of the os trigonum due to bullet. It is well to bear in mind, as I have pointed out, that these bones frequently have multiple centres of ossification.

Fracture of the hand sesamoids has been mainly seen in the metacarpo-phalangeal sesamoids of the pollex.

Parker, in 1901, reported the case of a woman who suffered from pain at the inner side of the head of the first metacarpal. The case was not X-rayed. Parker suggested that it was a case of sesamoid disability.

Preiser, in 1907, mentions a fracture of both sesamoids of the pollex in a woman

Morian, in 1909, describes a case of fracture of the ulnar sesamoid of a man, and shows different experimental varieties of fracture of the sesamoids of the pollex

Maas, in 1912, refers to another case of fracture of the ulnar sesamoid of the pollex in a man Skillern, in 1915, reports a similar case and repeats the experimental work of Preiser and Morian on the cadaver obtaining different types of fracture of the pollex sesamoids

Evans, in 1919, reports the case of a transverse fracture of the ulnar sesamoid of the pollex

In 1913 I was fortunate enough to meet with and reduce by an operation a dislocation of the phalanx of the pollex over the metacarpal head The dislocation followed a violent blow with a stick, producing hyperextension of the thumb, in a man aged forty The skiagram revealed a fracture of the radial sesamoid of the pollex metacarpo-phalangeal articulation

Contrary to what has been said in reference to the hallux, the sesamoids of the pollex often appear both fractured In rare cases of experimental fracture, as Preiser pointed out, the sesamoid appears to be the seat of marked comminution The transverse division is, however, the commonest direction of the fracture

A direct injury appears to be responsible for the multiplicity of the fragments produced, whereas a transverse or slightly oblique fracture seems to be the result of the so-called indirect injury A hand caught by a closing door, the impact of a falling body on the hand, falling on the hand, the dislocation of the primi-phalanx producing marked hyperextension of the pollex, such are some of the histories given, as indicating the mechanism of the fracture of the pollex sesamoids

Pain, tenderness, and swelling, localized to the metacarpal head, are the main features of the clinical picture

The trigger-finger is another injury of clinical importance, which is possibly associated with sesamoid structures Poirier, in 1889, suggested that the lateral ligaments of the metacarpo and interphalangeal joints were at fault This theory met with much criticism, and Adams remarked that Poirier's idea might apply to the hammer-finger only

Marchesi and Weir's papers and a study of the recorded cases lead me to suppose that the fibrous sesamoids of the interphalangeal joints are responsible in some cases for this curious disability There is no reason why the tendinous thickening felt in the palm of the hand should not be a secondary sequela It certainly improves in some cases after a course of physiotherapeutics only, as I have verified in two cases of my own

If this conception of the cause of the trigger-finger, in its earlier stages, is accepted, one may regard the snap-finger as a condition allied to the locking of a knee cartilage

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TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting Held May 2, 1921

TRANSPLANTATION OF UTERINE FIBROID TO THE OMENTUM WITH FORMATION OF A LYMPHANGIOMA OF THE OMENTUM

DRS JOHN H GIRVIN and JOHN SPEESE reported the history of a woman, thirty-nine years of age, who had noticed a lump in her abdomen for nearly three years, and within the past three months had had two severe and several slight attacks of abdominal pain which were supposed to be caused by a twisting of the pedicle of the intraabdominal mass. She was operated on at the Presbyterian Hospital on February 1, 1921, by Doctor Girvin.

Upon opening the abdomen, the omentum presented and was somewhat thickened and almost rigid. This was due to some engorgement of the vessels, especially on the right side where one was almost as large as one's little finger. The vessel was surrounded by a series of lymphatic cysts, those at the lower end as large as a small egg and grading down to the size of a large pea at the border of the stomach. These were under high tension and so closely arranged that they gave the stiff feeling to the omentum. At its lower edge, the omentum was attached to a pedunculated subserous fibroid growing from the left side of the fundus uteri. The tumor about the size of a grape fruit (Fig 1) had a pedicle about one inch long that had become twisted nearly three times so that the circulation was practically cut off and it was entirely nourished by the omental attachment. The omentum was detached and ligated by three ligatures and the largest cysts punctured. The tension was so great that the fluid spurted five or six feet.

The omentum was wrapped in pads and replaced in the abdomen and a supravaginal hysterectomy performed, with the removal of both tubes and ovaries, which were distinctly cystic. The body of the uterus was irregular, enlarged but rather soft. At the conclusion of the hysterectomy the omentum was examined, and, as the majority of the cysts were collapsed, it was replaced and the abdomen closed without drainage. She left the hospital in good condition on February 27th. She has had no abdominal symptoms since and her physician reports her now in very good condition.

One of the cysts removed for study shows, on microscopic examination, the wall to consist of the characteristics of omental tissue, in which numerous thin-walled vessels appear. These are uniformly lined with a layer of flat endothelial cells. Many of the vessels are collapsed, others are distended and contain homogeneous material, characteristic of lymph. The picture corresponds to that usually seen in lymphangiomatous formations.

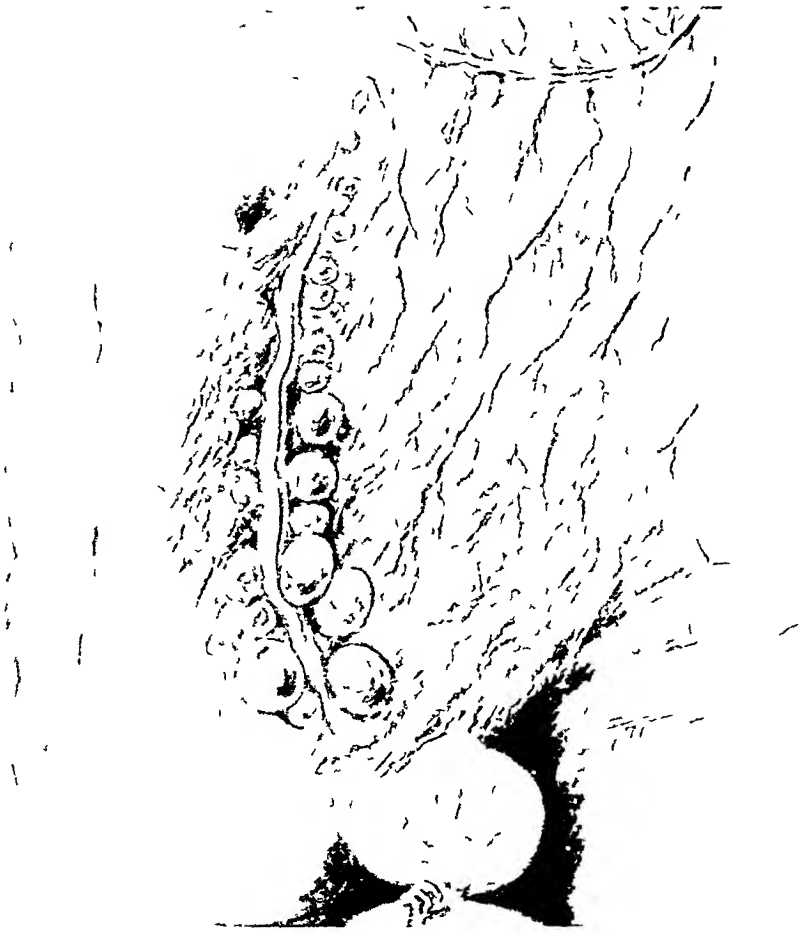


FIG. 1—Lymphangiomatous cysts of the omentum



FIG 2 —Outerbridge's case of cyst omentum

TRANSPLANTATION OF UTERINE FIBROID TO THE OMENTUM

The reporter said the subject of cystic lymphangioma of the great omentum was brought to the attention of the Academy in 1914 by Outerbridge, who then thoroughly reviewed the etiology of the condition. At this time about fifty cases of this comparatively rare disease were recorded in the literature. The case now described bears a striking resemblance to the one recorded by Outerbridge, the omentum being adherent to the uterine fibroid, the cystic tumors appearing in the free margin of the omentum and in close association with the omental blood-vessels.

If it is assumed that in the omentum the chief lymph channels follow the larger blood-vessels, Outerbridge believes by this anatomical condition can be explained the production of the more or less continuous chain of cystic structures around the entire edge of the great omentum. Any factor leading to obstruction of the lymphatics, inflammation, adhesions, etc., may cause cystic dilatation, and through proliferation of the endothelium give rise to true lymphangiomatous formation.

Jacobi states that all true omental cysts are lymphatic in origin. According to Stillman, it is significant that the swelling of the abdomen was first noticed at some period between the ages of one and ten in fifteen of twenty-one cases operated upon, and in ten of these, or nearly half of the cases he collected, the swelling was noticed between one and four years of age. While such facts point to the congenital nature of the cysts, and the possibility of a congenital origin from embryonic rests or from the surface peritoneum cannot be denied in certain cases, in the majority, however, it must be admitted, as proven, that the origin of such growths is to be found in the lymph-spaces.

Of the total of forty-six cases of omental cyst formation of all kinds, Stillman found but twenty-two to be true serous cysts, of these nine occurred between one to four years of age, six between five to eleven, the others at the ages of seventeen, nineteen, twenty-two, thirty and forty-two. Sixteen occurred in females and six in males.

The majority of the cases are discovered by accident in the course of operation for other abdominal conditions. In certain instances the large size of the cyst has brought about symptoms suggestive of ovarian cyst or ascites. In certain of the larger cysts complications develop which make surgical intervention necessary. Among these conditions are twisting of the pedicle with symptoms of appendicitis as reported in a boy of four by Speese, supuration and gangrene of omental cysts have also been reported.

The operation consists in removal of single cysts, or as much of the omentum as may be necessary when this structure is involved by multiple cysts. In the case reported complete extirpation of the cyst-bearing area of omentum, as recommended by some authors, was not undertaken because it was thought that with removal of the adhesions and detachment of the omentum from the uterus, obstruction of the lymphatic channels may have been sufficiently overcome to permit a return to a normal state of the omental

lymphatics So far there has been nothing in the post-operative history of the patient to suggest that such has not been the case

DOCTOR OUTERBRIDGE referred to a case which he had presented before this Academy seven years ago, which very closely resembled the case of Doctor Girvin's The case was a colored woman of thirty-four or thirty-five years of age, who had a fibroid tumor She was operated on by Doctor Beyea When the abdomen was opened a large mass which resembled grapes presented in the wound, on further examination this proved to be the omentum, around the entire edge of which were grapelike masses, ranging in size from that of a Malaga grape down to a pinhead, with a string of small ones running down through the centre of the omentum These masses were filled with a clear fluid The whole omentum along its free border was attached firmly to the upper surface of the subserous, pedunculated fibroid tumor growing from the fundus of the uterus There were very extensive evidences of inflammation throughout the pelvis, the tubes and ovaries being bound down by adhesions to the tumor In this case Doctor Beyea did a complete hysterectomy and also resected the omentum up to the transverse colon, ligating just below its attachments, so that we had the entire specimen for pathological study

A careful microscopical study was made of a number of the cysts of varying sizes In all instances the picture was practically identical—a fibrous wall containing more or less intense round-cell infiltration, lined on the side of the cyst cavity by a single layer of flat cells, similar to those seen lining the peritoneal cavity In the substance of the walls of many of the larger cysts were seen numerous irregular spaces of varying sizes, lined by similar cells, and containing a small amount of homogeneous material, taking a pinkish stain in hæmatoxylin-eosin preparations These represented, obviously, dilated lymphatic spaces Owing to the unbroken transition between these and the smaller cysts, and from them to the largest cysts, and also owing to the position of the cysts along the course of the larger blood-vessels with their accompanying perivascular lymph-spaces, he came to the conclusion that the specimen represented a lymphangioma, originating from the perivascular lymph channels, and due probably to the interference with the lymph current resulting from the extensive adhesions

In medical literature a number of very similar cases have been reported, arising in conjunction with omental adhesions to fibroid tumors

CHONDROFIBROMA OF THE FIBULA

DR ROBERT G LE CONTE reported the history of a woman, twenty-one years of age, who sought advice of Doctor Le Conte in November, 1919, for a swelling below and to the outer side of the left knee She could not remember when this first appeared, but stated that it had been present for some years Neither could she recall any injury to this region The tumor caused no pain and practically no disability The examination showed a large, firm, painless, non-inflammatory swelling over the upper part of the left fibula The general examination was negative The X-ray showed a tumor, apparently cystic, arising abruptly from the upper end of the fibula,

CHONDROFIBROMA OF THE FIBULA

which possessed a clear-cut bony capsule within which were several spicules of bone. The tumor, together with the head and upper third of the shaft of the fibula, were resected. The muscles were adherent over the tumor and there was slight attachment to the external lateral half of the tibia, corresponding to the shadow shown in the X-ray picture. The peroneal nerve was held in a groove in the tumor, and was separated with difficulty. After removal the bony capsule was found to be 5 mm thick, and the contents white and shiny, cutting like cartilage. The cortex of the fibula was very thin at the point of attachment. The wound was closed without drainage and primary union resulted. A diagnosis of sarcoma was made at the time of the operation. A histological diagnosis of myxofibroma was made by the laboratory. The recovery was uneventful but a definite degree of toe-drop resulted. Recent physical examination, March, 1921, shows that the toe-drop has definitely improved and there is elevation of the foot to about two-thirds of the normal motion and the patient states that she is able to do rhythmic dancing. The X-ray taken at this time showed definite recurrence of bony tissue in the soft tissues of this area and an enlargement and increase in the density of the shadow first noted in the tibia before the operation. Doctor Bloodgood, who saw the patient in consultation, considered these shadows an evidence of ossification at site of operation, and not a recurrence of the tumor.

A final histological study of the specimen, which has been confirmed by Dr Allan J Smith, shows the body of the tumor composed of a relatively small number of spindle-shaped fibrous-tissue nuclei, approximately normal in appearance, but haphazard in arrangement, and a much larger proportion of fibroglia fibrils. Small masses of cartilage are present throughout. A moderate number of small, thin-walled vessels can be seen. This structure is enclosed in a capsule composed of small bony fragments, separated by a fibrous structure. This connective tissue is like that within the tumor, except that it has an orderly arrangement about the bony spicules and contains a few giant cells with from six to twelve nuclei. This fibrous process penetrates entirely through the bony capsule and comes in contact with muscle tissue. The body of the tumor is doubtless neoplastic, while the capsule suggests a chronic fibrous osteoperiostitis. There is nothing, however, to suggest a malignant process. **Diagnosis** Chondrofibroma of the fibula.

Doctor Le Conte added that these cases are of interest in the light of the studies by Platou, Barrie, Coley and Bloodgood on *ostitis fibrosa cystica* and giant-cell tumors of the long bones. The purpose of these studies has been to place in the benign category certain osseous tumors formerly considered malignant, namely the so-called giant-cell sarcomas of the *epulis* type, and to establish a differential diagnosis between them and the malignant form of giant-cell sarcomas. These authors show that there is a close relationship between *ostitis fibrosa cystica* and giant-cell tumors, and suggest the possibility of their constituting a single progressive process. Barrie further suggests that they be considered as chronic inflammatory processes rather than neo-

plastic lesions, and advocates their treatment by conservative means. Bloodgood has reported thirty-five cases diagnosed bone cyst, or *ostitis fibrosa cystica*, and eighteen with the diagnosis of giant-cell sarcoma. The great majority of these were treated by curetting the cavities and swabbing them with carbolic acid and then alcohol. A few were treated by amputation. They were followed over a period of years, the longest fourteen, and in none did metastasis occur. A few developed local recurrence, which was cured by a second curettage or by amputation. Further evidence of the benign nature of the tumors of the long bones is furnished by Bloodgood, who reports that he has successfully curetted or resected several which had broken through or destroyed their capsule. All these authors, however, emphasize the difficulty of differentiating the benign from the malignant type in every case and agree that at present it cannot be done. Those cases from the Pennsylvania Hospital are placed on record for the purpose of aiding the study.

OSTITIS FIBROSA CYSTICA OF THE FEMUR

DR WALTER ESTELL LEE and DR W P BELK presented a man aged twenty-two years, who in October, 1918, while on duty at League Island Naval Station had a mild attack of influenza and following this he first suffered with pain in the middle third of his right thigh. After about a month's convalescence, and while running across the parade ground, he fell and fractured his right femur at the point where he had previously felt the pain. An X-ray examination of the fracture disclosed a bone cyst, and at the operation performed at the Naval Hospital necrotic and diseased bone was removed. The pathological diagnosis of this tissue was *ostitis fibrosa cystica*. Unfortunately they had been unable to obtain sections of this tissue from the hospital. The wound healed by primary intention and the patient was later seen by D J Chalmers DaCosta, and he recommended his discharge from the service with a diagnosis of bone cyst of the femur and a disability of 80 per cent.

He entered the Pennsylvania Hospital in March, 1920, where he was referred by the Public Health Service. The examination showed a well-nourished young man walking with a limp. A large scar was found over the outer surface of the right thigh and there was a thickening of the middle third of the right femur and some tenderness. This extremity was one inch shorter than the left. No muscular or cutaneous involvement was found. The X-ray report of Doctor Bowen described a cystic appearance of the femur beginning two inches below the trochanter and extending downward for ten inches. The possibility of sarcoma was suggested. There was hypertrophy and bowing of the bone at the seat of the fracture, which was well healed. At operation a long incision was made on the external surface of the thigh extending from the greater trochanter to the external condyle, exposing the femur for this distance. The medullary cavity of the bone was opened by chiseling a trough from the greater trochanter to the condyle. The bone was found to be very thin and in places barely of the thickness of

THROMBOSIS OF THE SUPERIOR MESENTERIC ARTERY

an egg shell There were three distinct cavities more or less separated by fibrous septa In these cavities a jelly-like substance about the color and consistency of currant jelly was found The entire medullary cavity was then curetted, which were followed by very free bleeding Carbolic acid was then applied to the walls of the cavity and finally this was neutralized with alcohol The wound was closed without drainage Primary union resulted and the recovery was uneventful He was discharged from the Pennsylvania Hospital four months later and referred to Dr William B Coley at the Memorial Hospital, New York, where radium and Coley's fluid were given A letter received from Doctor Coley states that recent X-ray and physical examination have failed to show any signs of recurrence Coley's fluid has been now discontinued because of severe reactions and an alarming loss of body weight

The histological study confirmed by Professor Allan J Smith of the material removed at the second operation shows small fragments of bone and blood which crepitate and break up like egg shell Histologically small, irregular islands of bone are surrounded by loose, cellular and fibrous tissues, which in places look much like normal bone-marrow Elsewhere there is much fibrous tissue which in places is rather cellular but has the appearance of chronic inflammatory process A few giant-cells containing from six to eight nuclei are seen near the bone fragments Considerable blood is present, but this could have easily been caused by the trauma of the curette Blood-vessels are numerous, but their coats are well formed The picture nowhere suggests a malignant process but rather a chronic fibrous osteomyelitis Final diagnosis Ostitis fibrosa cystica

THROMBOSIS OF THE SUPERIOR MESENTERIC ARTERY

DR LEO B REED reported the history of a woman, aged fifty, who was admitted to the Polyclinic Hospital at 3 15 A M, April 10, 1921, on the service of Dr George P Muller, suffering with intense, acute and paroxysmal abdominal pain The pain radiated from the right umbilical region to the lower abdomen—especially on the right side One year ago she had a similar attack and a second one, one month ago, both attacks however affecting her left side and lower left abdomen Neither of these attacks was so intensely severe as the one which brought her to the hospital

When admitted she had been suffering severe pain for three hours, she was in collapse with subnormal temperature, increased pulse-rate and respiration Temperature, 96 4°, pulse, 100, respiration, 32 Skin was cold and clammy She was nauseated and vomited frequently Complained of pain in the right and lower abdomen which was paroxysmal and progressively increased in intensity

The abdomen was flaccid on admission but half hour later had become boardlike, most marked in the right iliac fossa Generalized abdominal tenderness, also most marked in the right iliac fossa but not increased by deep palpation Abdomen was tympanitic throughout and peristalsis normal but

not visible No history of blood in her stools or painful defecation or tenesmus Slight grade of constipation

Laparotomy was immediately performed by Doctor Ravdin under ether anæsthesia

The lower ileum was found collapsed with slight injection of the blood-vessels The upper ileum and jejunum were distended and bluish in color, the picture resembling an intestinal obstruction Upon removing the intestines from the abdominal cavity there were found one large thrombus about two inches in diameter and several smaller ones, all in the mesentery of the small intestine, therefore involving the superior mesenteric artery There was no involvement of the mesentery of the large intestine No evidences of any effects from lack of blood supply could be detected except the bluish discoloration of the jejunum and upper ileum In the ileum, opposite the largest thrombus, was a definite constriction Above this point there was distention and below collapse of the intestine Appendix was found to be very greatly elongated and obliterated but not congested It was removed No free fluid was found in the peritoneal cavity

The abdomen was closed by the usual method without drainage The patient was put in the semi-Fowler position with continuous enteroclysis of 5 per cent solutions of sodium bicarbonate and glucose for forty-eight hours Patient's condition to date is very favorable

DOCTOR REED remarked that this is a mesenteric thrombosis of moderate grade which was not diagnosed previous to operation A review of the literature shows that the following symptoms should always call to mind this condition (1) Age—most common between ages of twenty to sixty (2) Abdominal pain—sudden, severe and colicky May be paroxysmal or continuous (3) Tenderness—extreme throughout whole abdomen (4) Abdominal distention is a constant sign and increases as the disease advances It is usually quite general, but there may be an occasional area of dullness due to oedema of the intestine which is common and early This may per se largely contribute to intestinal obstruction Accumulation of fluid in the flanks may give dullness (5) Palpable tumor, due to the formation of a hæmatoma between the layers of mesentery This may be hard to find on account of the extreme tenderness and rigidity (6) Rapid and excessive fall of temperature with weak and rapid pulse (7) Diarrhœa—due to irritation (8) Results of acute intestinal obstruction (a) Painful defecation, (b) obstinate constipation, (c) vomiting and nausea (9) History of an injury or some previous condition which might cause embolism

DR JOHN H JOPSON said that three cases of mesenteric thrombosis had been admitted to the Presbyterian Hospital during the past winter One of these cases was admitted to the medical service in a moribund state and died in a few hours Mesenteric thrombosis was found at the post-mortem examination Two cases were under his care on the surgical service In one case the condition occurred in a young married woman, twenty-eight years of age She was admitted to the hospital suffering with what was diagnosed

THROMBOSIS OF THE SUPERIOR MESENTERIC ARTERY

as an attack of pelvic peritonitis, of very acute onset. Appendectomy had been performed fifteen years previously. Causation of the condition was not to be explained. On opening the abdomen there was found a cavity in the pelvis filled with blood, mixed with a small amount of pus, and not connected with the uterus or adnexa. Its walls were formed by adherent loops of bowel, which in places exhibited patches of gangrene. The cavity was drained, and a few days later the patient developed a complete fecal fistula, and following this improved markedly and rapidly. About six inches of intestine were discharged from the wound as a necrotic mass and the intestines were moved entirely through the wound. One month after the first operation the abdomen was reopened and it was found that the last portion of the ileum had sloughed just above the ileo-cæcal valve, and the remaining ends were lying open at this point, and resembling the double-barrel appearance of a two-stage enterectomy. Anastomosis of the terminal ileum with the ascending colon was followed by recovery.

The remaining case was the most interesting. If it had not been for the influence of Dr. George G. Ross's paper, read before the 1920 meeting of the American Surgical Association, the result would probably have been less fortunate, as he would have felt impelled to do a very radical operation. The patient, a negro cook, about fifty years of age, was admitted with a diagnosis of appendicitis, made by an outside physician, and of acute onset, and about four hours' standing. Morphine had been administered, and immediate operation urged. Before operation there seemed no reason to interpret the history or physical signs differently, the local symptoms being characteristic. The patient showed however a low temperature and seemed somewhat shocked. Operation six hours after onset of pain. The abdomen was found well filled with blood. The appendix was normal. The last four feet of the ileum were swollen, congested, the site in the mesentery, of a thrombosis extending well toward the base of the same. The hemorrhage had occurred from the serous surface of the gut. The latter looked still viable. We recalled that in a similar case of Dr. John B. Deaver's, reported in Ross's series, he had closed the abdomen in the face of similar findings, and that the patient recovered. Also that this was the only operated case which did recover. We therefore wiped out some of the blood and closed the abdomen. The post-operative course was marked by an incomplete intestinal obstruction which yielded to treatment, including repeated gastric lavage. This patient also recovered. In reply to a question concerning the occurrence of intractable hemorrhage, he recalled that the last case had tarry stools, the other two he thought had not this symptom.

DOCTOR DESPARD said that he had recently had a case of mesentery thrombosis in a young woman twenty-five years of age, which seemed to be associated with an attack of influenza accompanied with sore throat, followed by diarrhoea which lasted for several days before distinct abdominal symptoms of a serious nature made their appearance. With the decrease in the number of bowel movements, violent peristaltic pains commenced and persisted for

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twenty-four hours, at the end of which time she passed a small amount of clotted blood. During the next eighteen hours there were six movements of liquid blood. When admitted to the Methodist Hospital the symptoms were those of obstruction with peritonitis. Upon opening the abdomen he found extensive gangrene of a part of the ascending and the entire transverse colon, as well as a large part of the omentum.

Resection seemed the only possible procedure, which was done as expeditiously as possible. The patient stood the operation well and the following day was comfortable and sanguine of her own recovery. While there were no further abdominal symptoms, her pulse became progressively more rapid and weak, and she died on the second day after the operation, apparently overwhelmed by toxins, as so many obstruction cases do.

MALIGNANT DEGENERATION OF BENIGN TUMORS OF THE THYROID GLAND

A paper with the above title was read by DR. JOHN SPEESE, for which see page 684.

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A MONTHLY REVIEW OF SURGICAL SCIENCE AND PRACTICE

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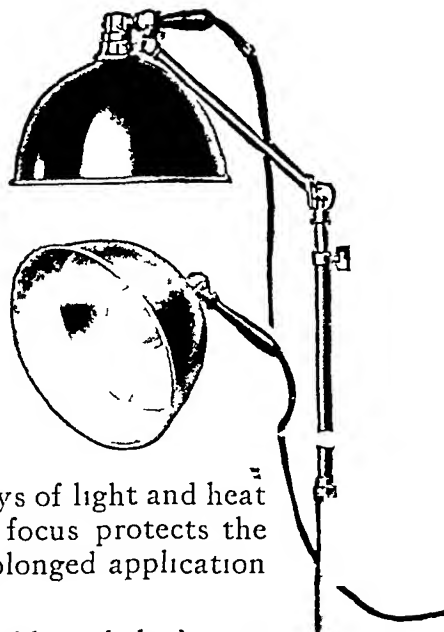
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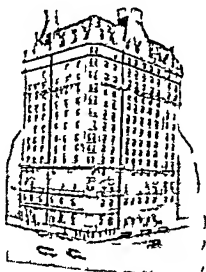
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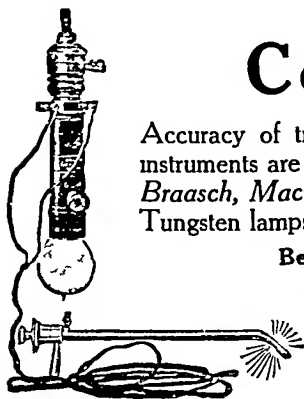
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